T-M32 / T-M32 ASME

On-demand Water Heater

Service manual

T-M32

A.O. Smith Water Products Company
500 Tennessee Waltz Parkway
Ashland City, TN 37015
Toll Free: 1-877-737-2840

Table of Contents

1. Specifications..... 3
2. Exterior view..... 4
3. Interior view..... 5
4. List of main components in the interior view..... 6
5. Schematic diagram..... 8
6. Wiring diagram..... 9
7. Wiring diagram checkpoints for diagnosis..... 10
8. Resistance values of the temperature thermistors..... 12
9. Operational flow chart..... 13
10. Component specifications..... 14
11. Fault Analysis & Specifications..... 35
12. Controls and settings..... 46
13. Components diagrams..... 75
14. Parts list..... 78
15. Revisions..... 82

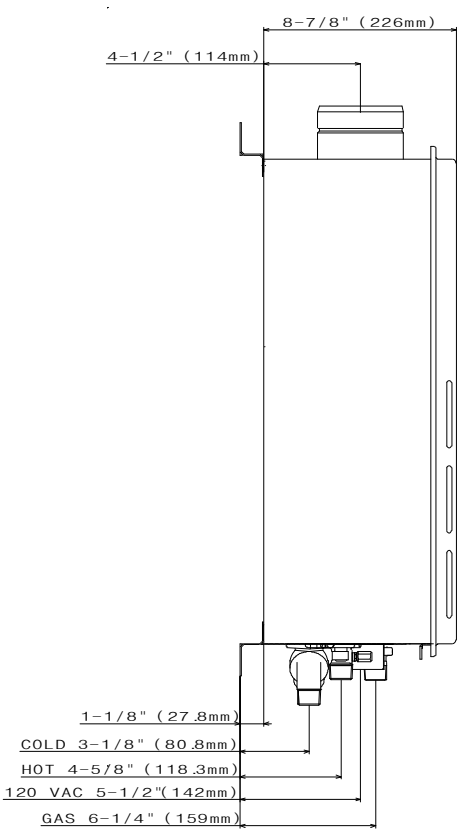
1. Specifications

Unit Model			T-M32 / T-M32 ASME
Unit dimensions			H 23.6"×W 18.5"×D 8.9"
Weight			59 lbs.
Combustion	INPUT BTU/h	Max	240,000
		Min	24,000
	Combustion System		Power vent
	Installation		Indoor, Outdoor, Direct vent
	Fan motor		PWM Turbo fan
	Manifold Pressure*	Max	LP 3.4" WC Natural 2.3"W.C
		Min	LP 0.7 WC Natural 0.5" WC
Water control	Flow rate		0.5 to 9.0 GPM
	Available set temp.		100°F to 185°F default set 120 °F
	Temperature dipswitch setting		100°F, 115°F, 120°F, 135°F, 145°F, 155°F, 165°F, 185°F
	Bypass valve		Yes
	Thermistors		3 thermistors (In, Out, Mixing)
Operation	Available remote controller		TM-RE30
	PCB Model		T-M32 (Part # EM376)
	Indicators		Red LED on PCB during operation & 7-seg LED
	Power supply control		GFI & Surge absorber
Future	Freeze protection		Ceramic heaters and Auto- FM system
	Self-combustion improvement		Air Fuel Ratio detection system
	Easy-link system		Yes
	Multi-unit system		Yes

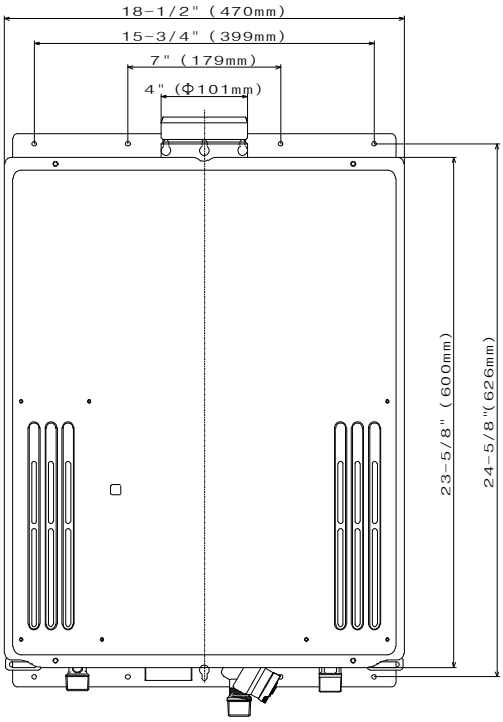
*The manifold pressure measurement is base on conditions without front cover.

2. Exterior view

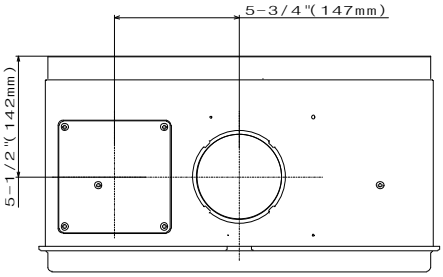
Side view



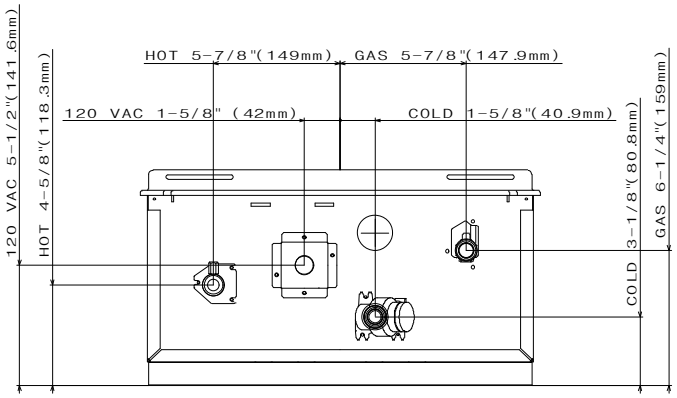
Front view



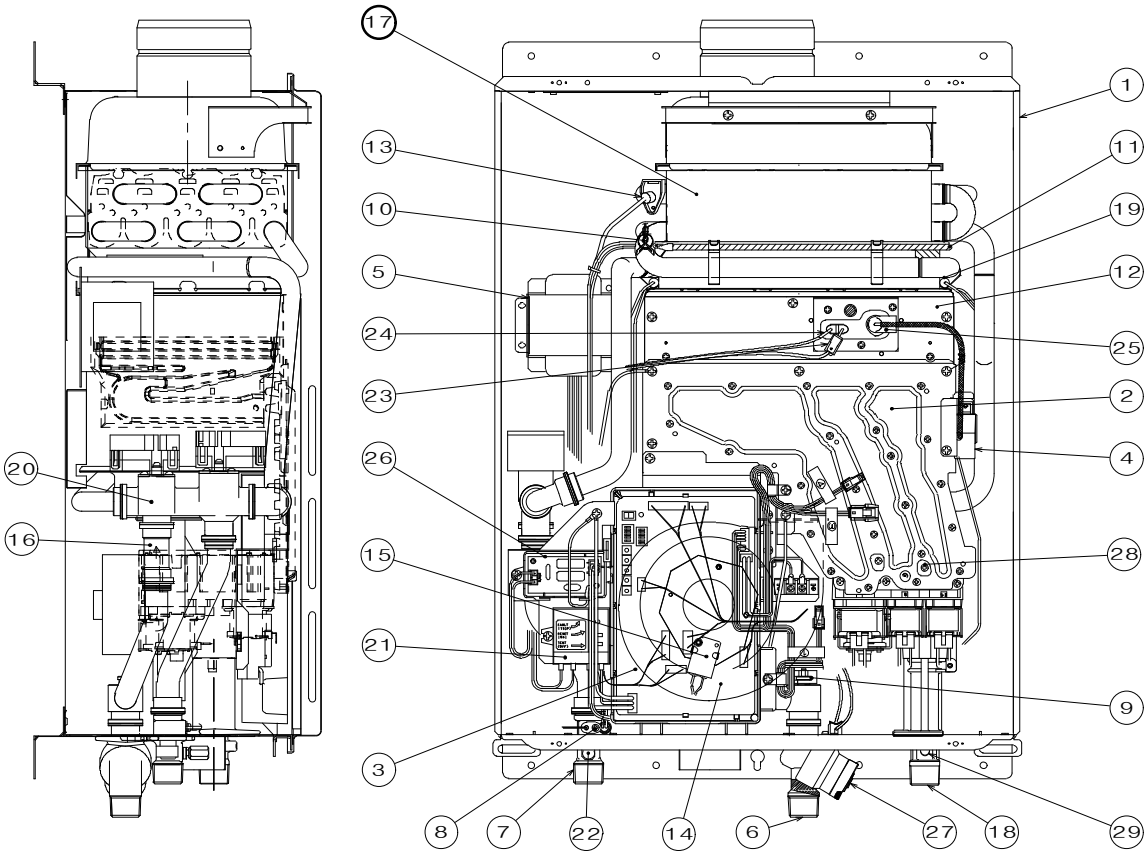
Top view



Bottom view



3. Interior view

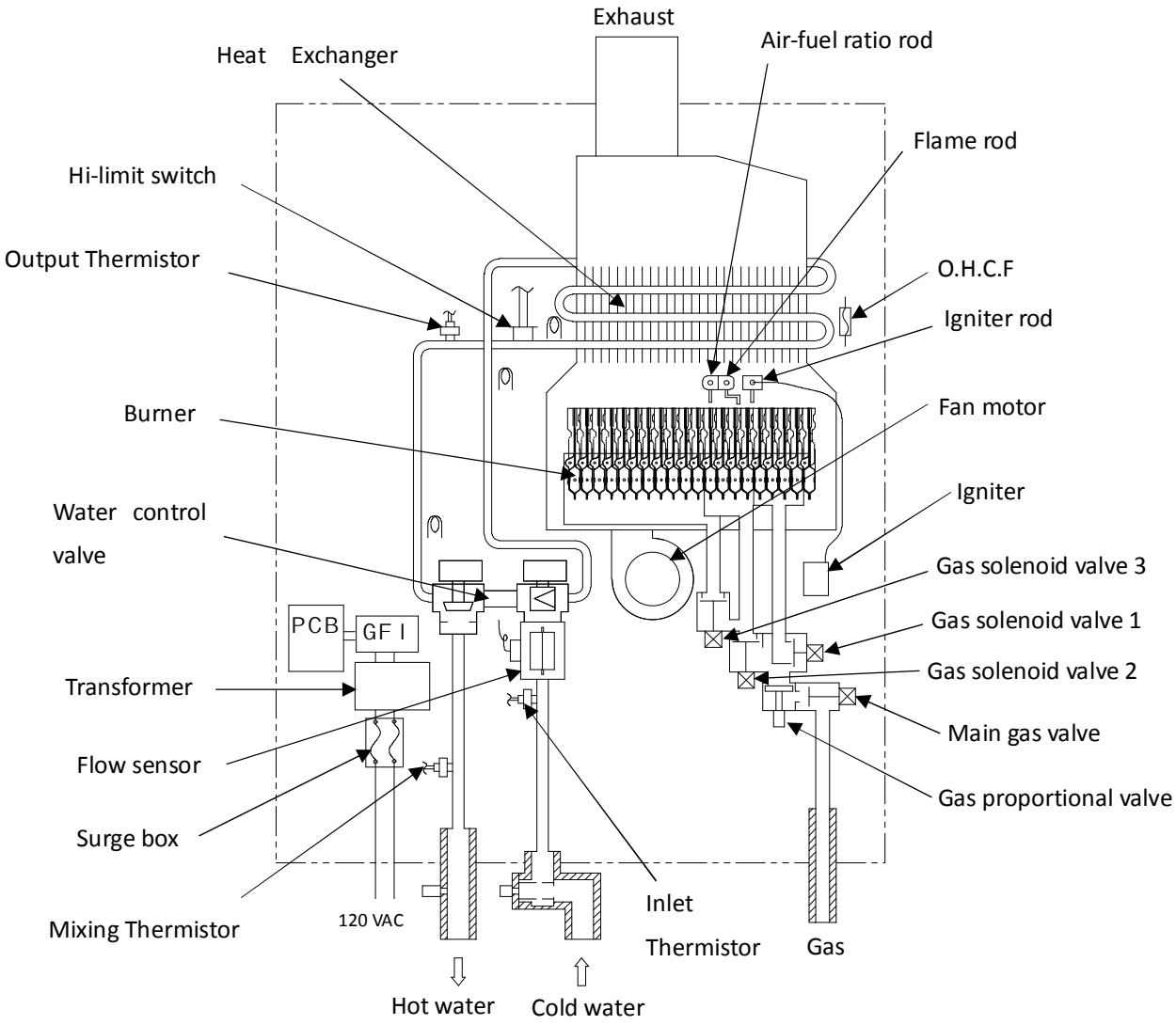


4. List of main components in the interior view

No.	Description	Items# in components diagram	Takagi Part #	Common parts For other models
1	Case assembly	001	EM389	
2	**Manifold assembly with gas valve assembly**	**120**	**EM440 (LP model) EM441 (NA model)**	
3	Computer board	701	EM376	
4	Igniter	125	EKN74	T-K3, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
5	Transformer	702	EM454	
6	Water inlet	411	EM404	T-H2-DV/OS
7	Water outlet	435	EKJ02	
8	Mixing thermistor	418	EX00H	T-H2-DV/OS
9	Inlet thermistor	422	EKK38	T-K3, T-K3-Pro, T-H2-DV/OS, T-D2-IN/OS, T-M50
10	Output thermistor	433	EKK2T	T-K3, T-K3-Pro, T-H2-DV/OS, T-D2-IN/OS, T-M50
11	Overheat cut-off fuse	403	EM387	
12	Burner assembly (Burners)	101	EM410	
13	Hi-limit switch	432	EKN34	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-D2-IN/OS, T-M50
14	Fan motor	115	EKK25	T-K3, T-K3-Pro, T-K3-SP, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
15	Freeze protection thermostat	117	EKJ59	T-K3, T-K3-Pro, T-K3-SP, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS

No.	Description	Items# in components diagram	Takagi Part #	Common parts For other models
16	Flow sensor	429	EKH33	T-H2-DV/OS, T-M50
17	**Heat exchanger**	**210**	**EM415 (Regular model)**	
		211	**EM45C (ASME model)**	
18	Gas inlet	123	EM442	
19	Heater	410	EX002	T-H2-DV/OS, T-M50
20	Water control valve	423	EKH32	T-H2-DV/OS, T-M50
21	GFI	712	EM207	T-M50
22	Outlet drain plug	416	EK239	T-H2-DV/OS
23	Air-fuel ratio rod (AFR rod)	106	EKK0E	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
24	Flame rod	106	EKK0E	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
25	Igniter rod	108	EKK0F	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
26	Surge box	715	EM385	T-M50
27	Inlet drain plug (water filter)	408	EX006	T-H2-DV/OS, T-M50
28	Manifold port	N/A	N/A	
29	Gas inlet port	N/A	N/A	

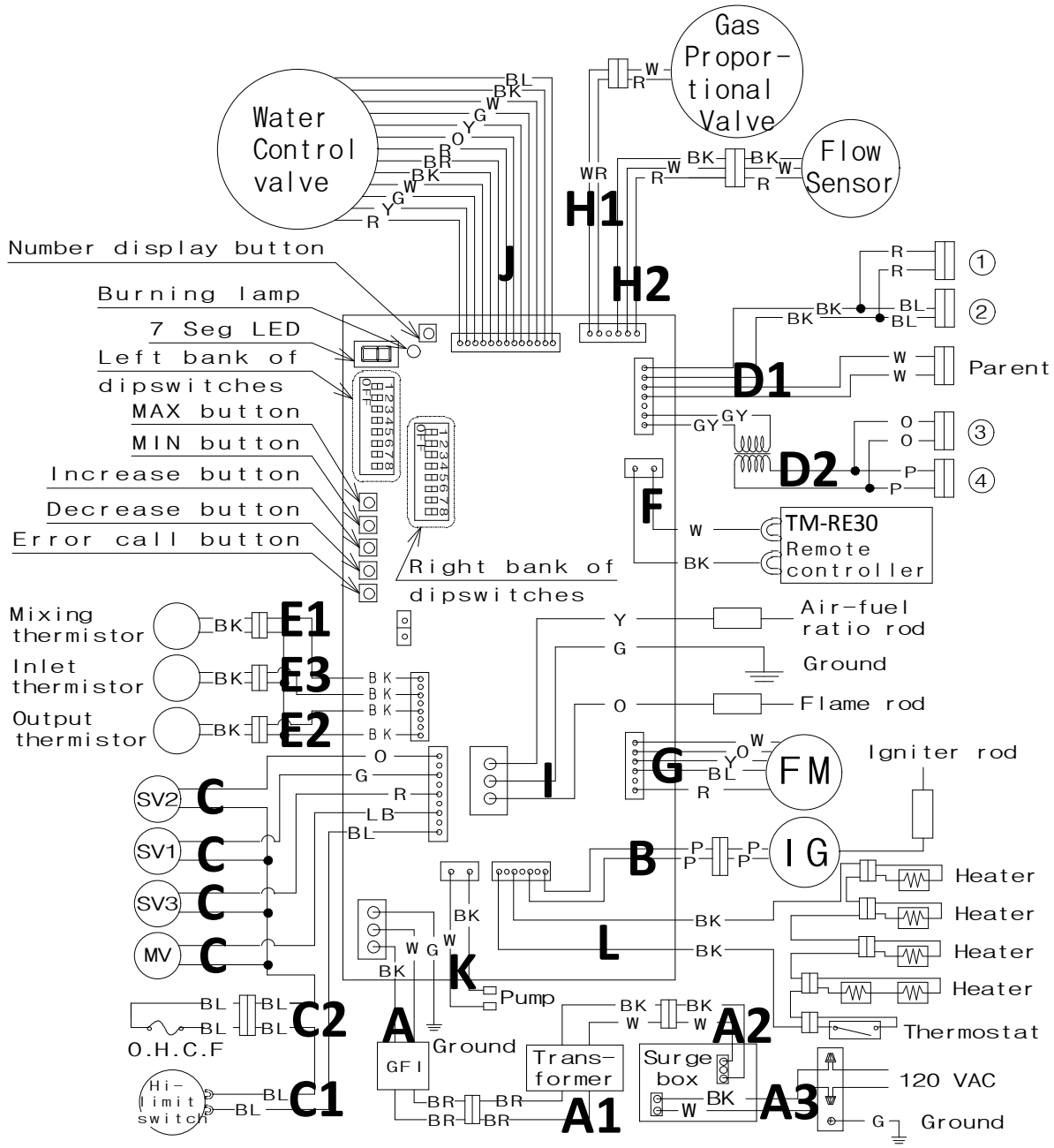
5. Schematic diagram



1. When a hot water tap is opened, cold water enters the T-M32.
2. The water flow sensor detects this water flow and sends this information to computer.
3. The computer initiates fan motor and sends signal to igniter to create ignition spark.
4. The main, proportional, and solenoid gas valves open to allow gas input.
5. The gas ignites and flames appear inside the burner chamber.
6. Water circulates through the heat exchanger and is heated up to the set temperature.
7. Using thermistors to measure temperatures, the computer modulates the gas and water valves to ensure proper output water temperatures.
8. When the tap is closed, the T-M32 shuts down.

6. Wiring diagram

BK: BLACK LB:LIGHT BLUE G: GREEN O: ORANGE
P: PURPLE BL: BLUE Y: YELLOW BR:BROWN
W: WHITE R: RED GY:GRAY



7. Wiring diagram check points for diagnosis

Check-point	Parts and Description	Color of wires	Normal Range
A, A1	100 V Power supply	White – Black (A) Brown – Brown (A1)	90 to 110 VAC
A2,A3	120 V Power supply	Black - White	108 to 132 VAC
B	Igniter	Purple – Purple	90 to 110 VAC
C	Gas valves	Light blue - blue at COM (MV)	78 to 100 VDC (during operation) / 0.9 to 1.3kΩ
		Green - blue at COM (SV1)	78 to 100 VDC (during operation) / 1.3 to 1.9kΩ
		Orange - blue at COM (SV2)	78 to 100 VDC (during operation) / 1.3 to 1.9kΩ
		Red - blue at COM (SV3)	78 to 100 VDC (during operation) / 0.9 to 1.7kΩ
C1	Hi-Limit switch	Blue - Blue	Less than 1 VDC and less than 1 Ω
C2	Overheat cutoff fuse	Blue - Blue	Less than 1 VDC and less than 1 Ω
D1	Easy-link connectors	White - White	15 VDC
		Red – Red Blue – Blue	15 VDC (during Easy-link operation)
D2	Multi-unit link connectors	Purple- Purple Orange -Orange	15 VDC (during Multi-unit operation)
E1	Mixing thermistor	Black - Black	See table on p.12
E2	Output thermistor	Black - Black	
E3	Inlet thermistor	Black - Black	
F	Remote controller	Black - White	11 to 25 VDC
G	Fan motor	Red - Blue	110 to 160 VDC
		Yellow - Blue	13 to 17 VDC
		Orange - Blue	2 to 6.5 VDC
H1	Gas proportional valve	White - red	1 to 15 VDC (during operation) and 20 to 40 Ω

Check-point	Parts and Description	Color of wires	Normal Range
H2	Flow sensor	Red - Black	4 to 5.5 VDC
		White(+) – Black(GND)	1 to 4 VDC (1,200 Pulse/min)
I	Air-fuel ratio rod	Yellow – AFR rod (Between AFR rod and the computer board)	More than 0.5 µA (during operation)
	Flame rod	Orange – Flame rod (Between flame rod and the computer board)	More than 1 µA (during operation)
J	Water control valve	Blue – Brown Orange – Brown Red – Brown	13 to 16 VDC ON: 12.5 to 16 VDC OFF: 0 to 1 VDC 1 VDC Less (0°C position)
K	Pump connector	White - Black	Less than 1.3 Ω
L	Heater	Black – Black	90 to 110 VAC

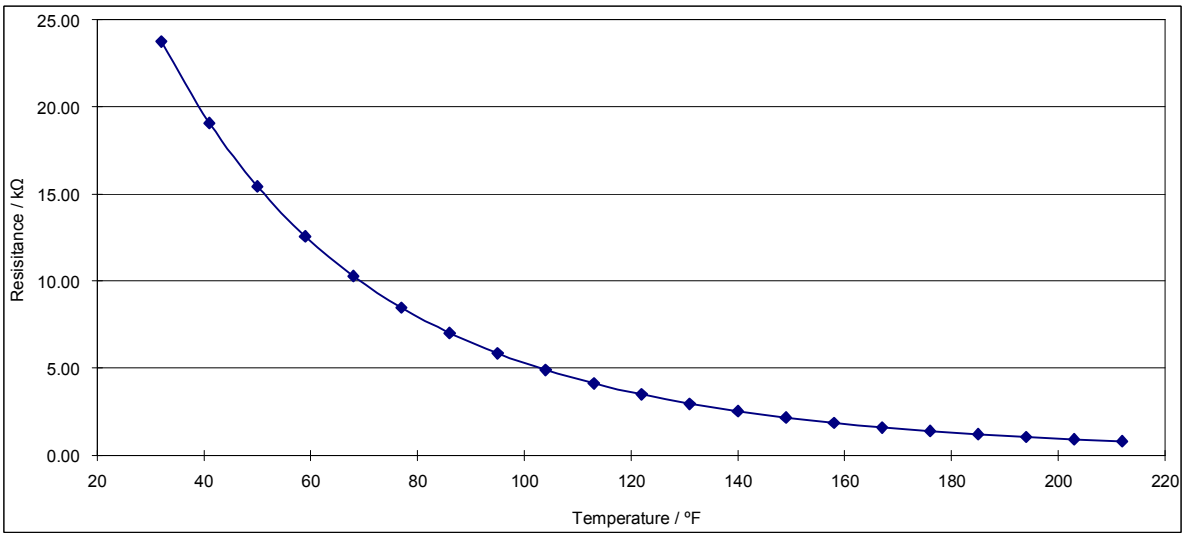
8. Resistance values of the temperature thermistors

Resistance values at different temperatures

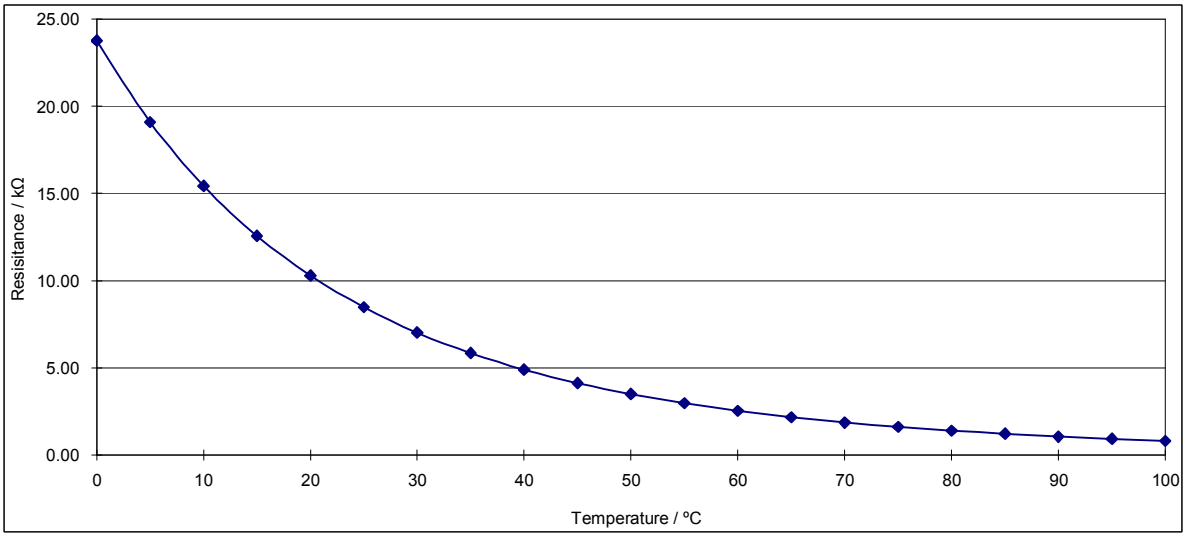
Temperature	°F	32	41	50	59	68	77	86	95	104	113
	°C	0	5	10	15	20	25	30	35	40	45
Resistance	kΩ	23.76	19.08	15.43	12.56	10.28	8.47	7.02	5.85	4.90	4.12

Temperature	°F	122	131	140	149	158	167	176	185	194	203	212
	°C	50	55	60	65	70	75	80	85	90	95	100
Resistance	kΩ	3.49	2.96	2.53	2.16	1.86	1.60	1.39	1.21	1.05	0.92	0.81

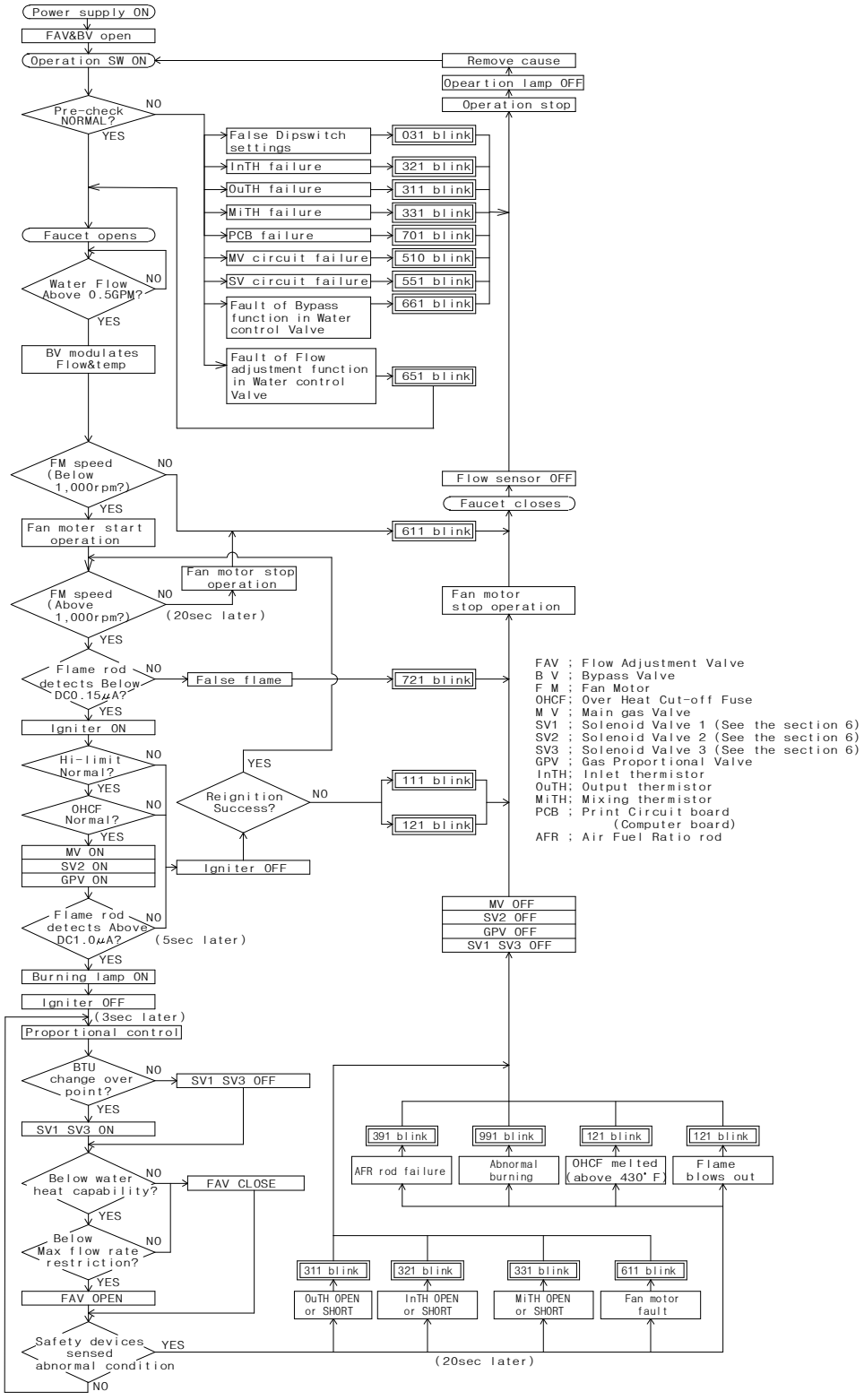
Temperature / °F vs Resistance / kΩ



Temperature / ℃ vs Resistance / kΩ



9. Operational flow chart



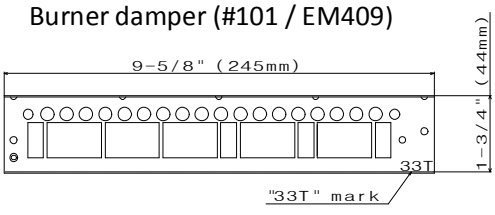
10. Component specifications

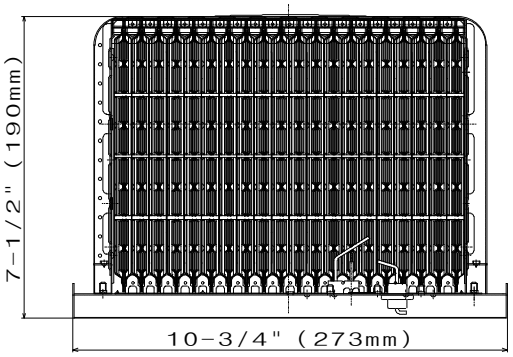
10-1. Burners..... 15
10-2. Gas manifold..... 16
10-3. Fan motor..... 17
10-4. Gas valve assembly..... 18
10-5. Flame rod..... 19
10-6. AFR rod..... 20
10-7. Heat exchanger..... 21
10-8. Flow sensor..... 22
10-9. Water Control valve..... 23
10-10. Thermistors..... 25
10-11. Hi-limit switch..... 26
10-12. Overheat cutoff fuse..... 27
10-13. Freeze protection heaters..... 28
10-14. Computer board..... 29
10-15. Transformer..... 30
10-16. GFI..... 31
10-17. Igniter..... 32
10-18. Freeze protection thermostat..... 33
10-19. Surge box..... 34

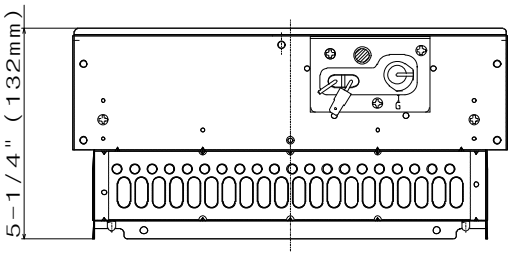
10-1. Burners

Unit Part #	#101	**AOS Part #**	EM410	**Checkpoint**	**N/A**
Function	There are 2 types of burners in the water heater: the gas-rich burner stabilizes the flames within the combustion chamber and the air-rich burner produces more heat in the combustion chamber. The burners facilitate the air/gas mixture necessary to produce the proper heat during the combustion reaction.				
Failure event	1. Unable to initialize/sustain combustion. 2. Dust or soot deposit on the burner surface. 3. Cracks of the burners. 4. Gas leakage from the burners.				
Effects on the water heater if burners fails	1. Unexpected combustion. 2. Unstable flame conditions and/or flame loss. 3. Ignition failure. 4. Back-firing.				
Error codes when the burners fails	**101**	**111**	**121**	**991**	
Diagnostic	Visual inspection: excessive dust deposit on the burner surface and/or unstable flame conditions during operation.				
Color / Number of wires	**N/A**				

Burner damper (#101 / EM409)





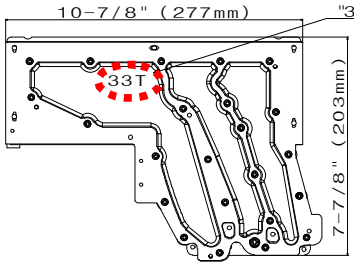


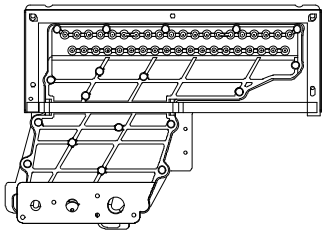
The burner damper is not included in EM410.

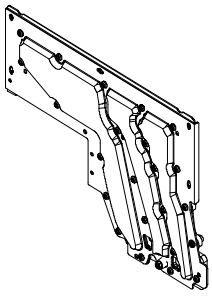
10-2. Gas manifold

Unit Part #	#120	**AOS Part #**	EM440 (LP model) EM441 (NA model)	**Checkpoint**	**N/A**
Function	1. The manifold distributes gas from the gas valves to the burners. The manifold has two types of the nozzles: one type for gas-rich burners (20 nozzles) and the other for air-rich burners (19 nozzles) 2. There are 3 zones within the manifold, to ensure efficient combustion operation.				
Failure event	1. Dust deposit on the manifold. 2. Gas leakage from a failed manifold. 3. Ignition failure. 4. Imperfect combustion.				
Effects on the water heater if the manifold fails	1. The burners cannot receive proper gas flow from the manifold, which can cause poor combustion in the combustion chamber. In this case, the AFR rod will detect an improper flame condition and computer will take safety measures. 2. Gas leakage from the manifold.				
Error codes when the manifold fails	**101**	**111**	**121**	**991**	
Diagnostic	1. Visual inspection: Excessive dust deposit around the nozzles or cracks on the manifold. 2. Check voltages and resistance: proper range of values shown below.				
Color / Number of wires	Blue-Red		78 to 100 VDC / 0.9 to 1.7 kΩ		

EM440 (for LP model) and EM441 (for NA model) is an assembly of the gas manifold with the gas valve assembly. For safety reasons, these assemblies should be installed in the unit as a whole set.
The gas manifold has the “33T” mark on the manifold plate.



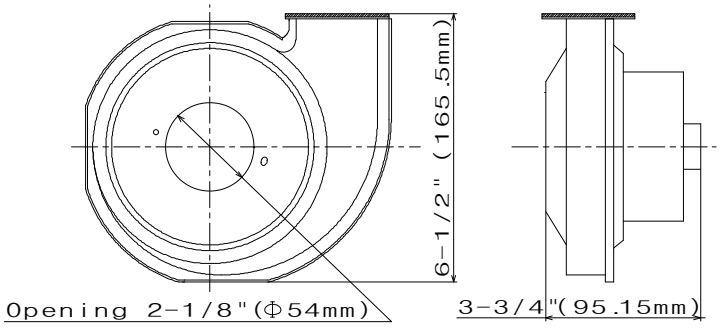




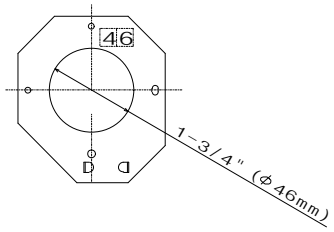
10-3. Fan motor

Unit Part #	#115	**AOS Part #**	EKK25	**Checkpoint**	**G**
Function	To provide combustion air into the combustion chamber and to exhaust flue gas.				
Failure event	1. Fan speed failure, causing abnormal sounds with or without combustion during operation. 2. Unexpected activation caused by the connectors of the fan motor getting wet. 3. Disconnects from the bottom of the combustion chamber.				
Effects on the water heater if fan motor fails	1. The water heater does not function properly 2. Failure to ignite or abnormal ignition 3. Unstable combustion conditions				
Error codes when the fan motor fails	**101**	**111**	**121**	**611**	**991**
Diagnostic	1. Visual inspection: connection / breakage of wires or dust (causing electrical shortage) 2. Voltage check: proper range of voltages shown below.				
Color / Number of wires	Red-Blue	110 to 160 VDC (Input)			
	Yellow-Blue	13 to 17 VDC (Input)			
	Orange-Blue	2.0 to 6.5 VDC (Input)			
	White-Blue	Verify the fan motor speed using the Diagnostics Mode of the temperature remote controller. See Section 12-1 for details.			

PWN turbo fan motor



The fan damper is not included in EKK25.

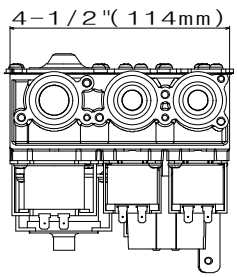


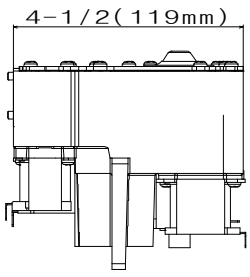
Fan damper (#116 / EM381)

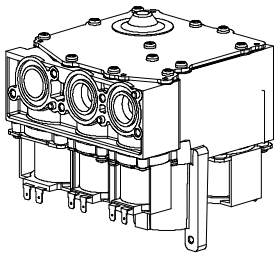
10-4. Gas valve assembly

Unit Part #	#120	**AOS Part #**	EM440 (LP model) EM441 (NA model)	**Checkpoint**	**C,H1**
Function	Opens and closes the gas pathways of the water heater (main and solenoid gas valves)				
	Modulates the gas flow from the gas inlet (proportional gas valve)				
Failure event	1. Gas leak from the valves. 2. Unable to open /close (main and solenoid gas valves) 3. Unable to modulate the gas flow (proportional gas valve)				
Effects on the water heater if valves fails	1. Gas leak from the unit. 2. Excess carbon monoxide emissions. / No flames. 3. Lack of water temperature control.				
Error codes when the valves fails	**111**	**121**	**510**	**701**	
Diagnostic	1. Visual inspection: connection / breakage of wires. 2. Listen for "clunk" sounds from the gas valves opening right after fan motor initiates. 3. Check voltages and resistance of coils; proper range of values shown below.				
Color / Number of wires	Blue -Light blue	78 to 100 VDC (during operation) / 0.9 to 1.3 kΩ			
	Blue -Green	78 to 100 VDC (during operation) / 1.3 to 1.9 kΩ			
	Blue -Orange	78 to 100 VDC (during operation) / 1.3 to 1.9 kΩ			
	Blue -Red	78 to 100 VDC (during operation) / 0.9 to 1.7 kΩ			
	White –Red (Proportional valve)	1.0 to 15 VDC (during operation) / 20 to 40 Ω			

EM440 (for LP model) and EM441 (for NA model) is an assembly of the gas manifold with gas valve assembly. For safety reasons, these assemblies should be installed in the unit as a whole set. The diagram below shows the gas valve assembly.



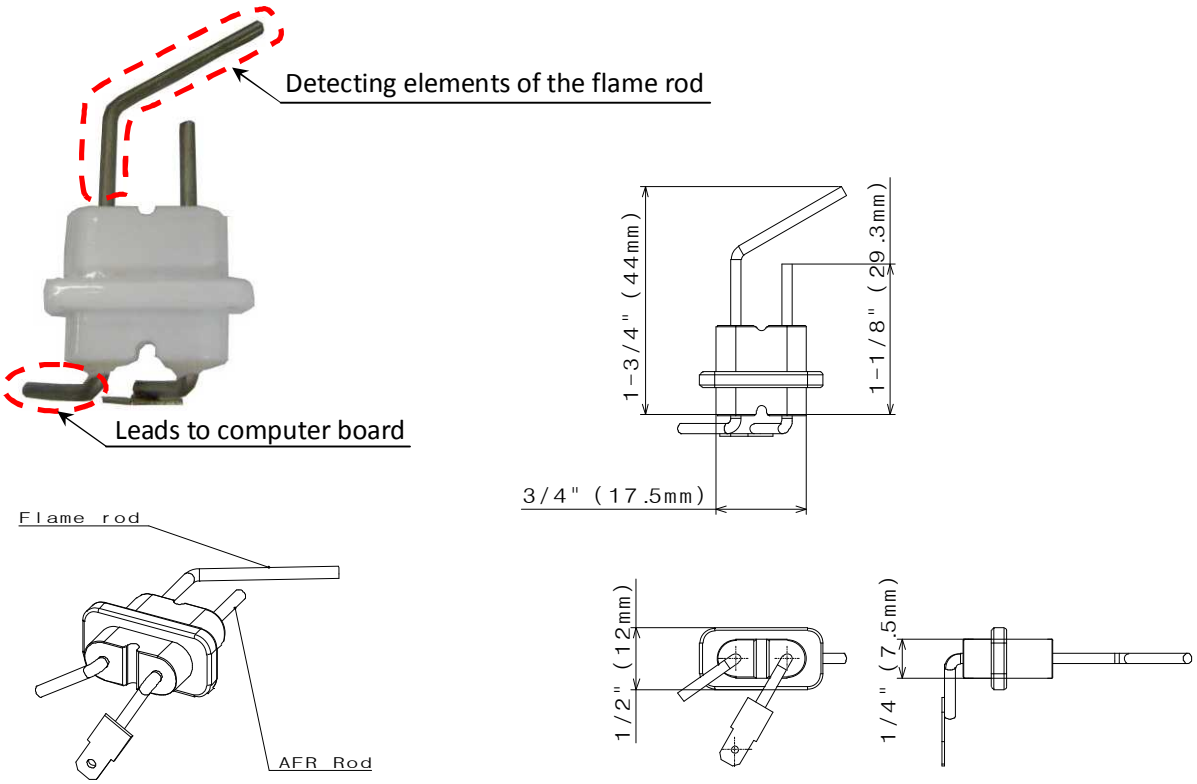




10-5. Flame rod

Unit Part #	#106	**AOS Part #**	EKK0E	**Checkpoint**	I
Function	To detect flames while the water heater is in operation.				
Failure event	1. Unable to detect flames when flames actually do occur 2. Detecting a false flame when no flames actually occur				
Effects on the water heater if flame rod fails	1. The water heater stops operating. The "111" and/or "121" error code(s) will display. 2. The water heater will not initiate the ignition process. The "721" error code will display.				
Error codes when the flame rod fails	**111**	**121**		**721**	
Diagnostic	1. Visual inspection: connection / breakage of wires or soot buildup on rod. 2. Check amperes: proper range of values shown below.				
Color / Number of wires	Orange(17) - Flame rod (Between the flame rod and the computer board)	(During operation) More than DC 1 µA			

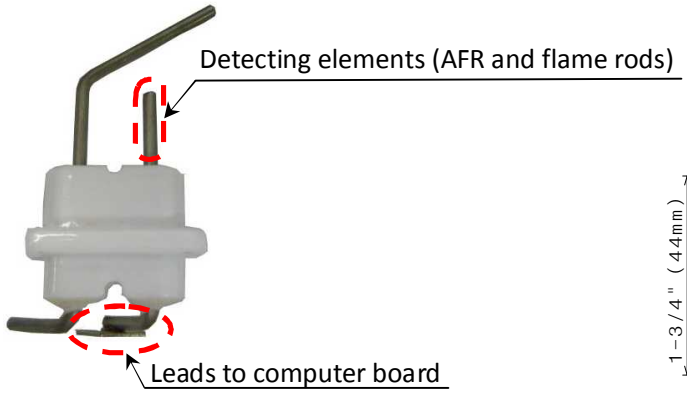
The flame rod is assembled with the AFR rod.

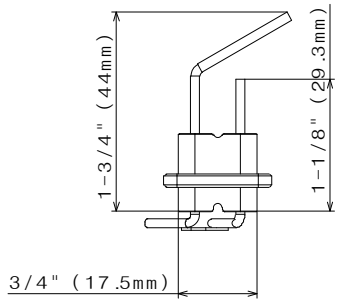


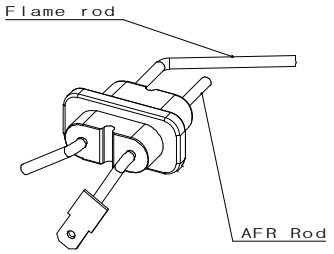
10-6. AFR rod

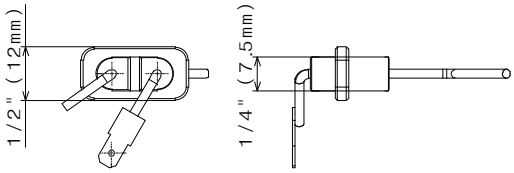
Unit Part #	#106	**AOS Part #**	EKK0E	**Checkpoint**	I
Function	-Checks flame conditions during combustion. -When AFR rod detects unexpected flame conditions, the the computer of the water heater makes adjustments in the fan motor speed to compensate.				
Failure event	1. Unable to detect flames when flames actually do occur 2. Detecting a false flame when no flames actually occur				
Effects on the water heater if AFR rod fails	1. The water heater will not initiate the ignition process. The "721" error code will display. 2. The fan motor speed cannot be modulated properly under abnormal flame conditions, which can result in excessive CO emission.				
Error codes when the AFR rod fails	**101**		**391**		**991**
Diagnostic	1. Visual inspection: connection / braking of wires, soot on it. 2. Check voltages: proper range of values are shown below.				
Color / Number of wires	Yellow(8) - AFR rod (Between the flame rod and the computer board)		(During operation) More than DC 0.5 µA		

The AFR rod is assembled with the flame rod.









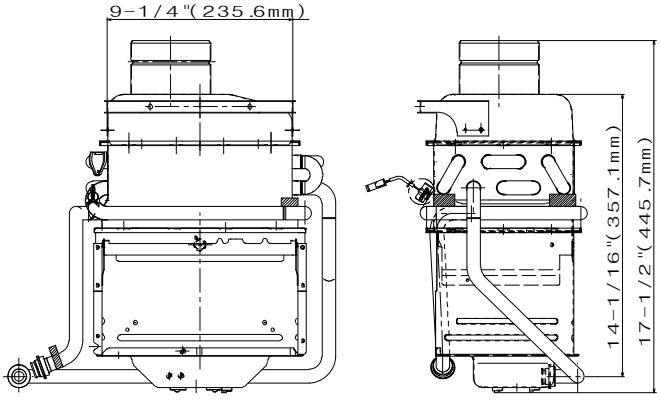
10-7. Heat exchanger

Unit Part #	#210 (Regular model) #211 (ASME model)	**AOS Part #**	EM415 (Regular model) EM45C (ASME model)	**Check point**	**N/A**
Function	Absorbs heat from combustion and transfer it to water through the heat exchanger pipes.				
Failure event	1. Clogged heat exchanger fins and/or cracks on the heat exchanger walls. 2. Leaking exhaust gas. 3. Improper heat transfer can cause the water in heat exchanger to boil.				
Effects on the water heater if the heat exchanger fails	1. Water leakage from the heat exchanger 2. Exhaust gas leakage (if this occurs, an overheat cutoff fuse is in place to detect this event and immediately stop the water heater from operating) 3. Abnormal sounds during combustion				
Error codes when the heat exchanger fails	**N/A**				
Diagnostic	1. Visual inspection: soot deposits, cracks on the heat exchanger walls, and/or water leakage from the heat exchanger. 2. In the event of abnormal sounds during combustion: A. Inspect for soot buildup inside the heat exchanger. B. Inspect for scale buildup inside the heat exchanger pipes. Scale buildup obstructs proper heat transfer to the water, thereby overheating the heat exchanger and causing damage.				
Color / Number of wires	**N/A**				

ASME Model

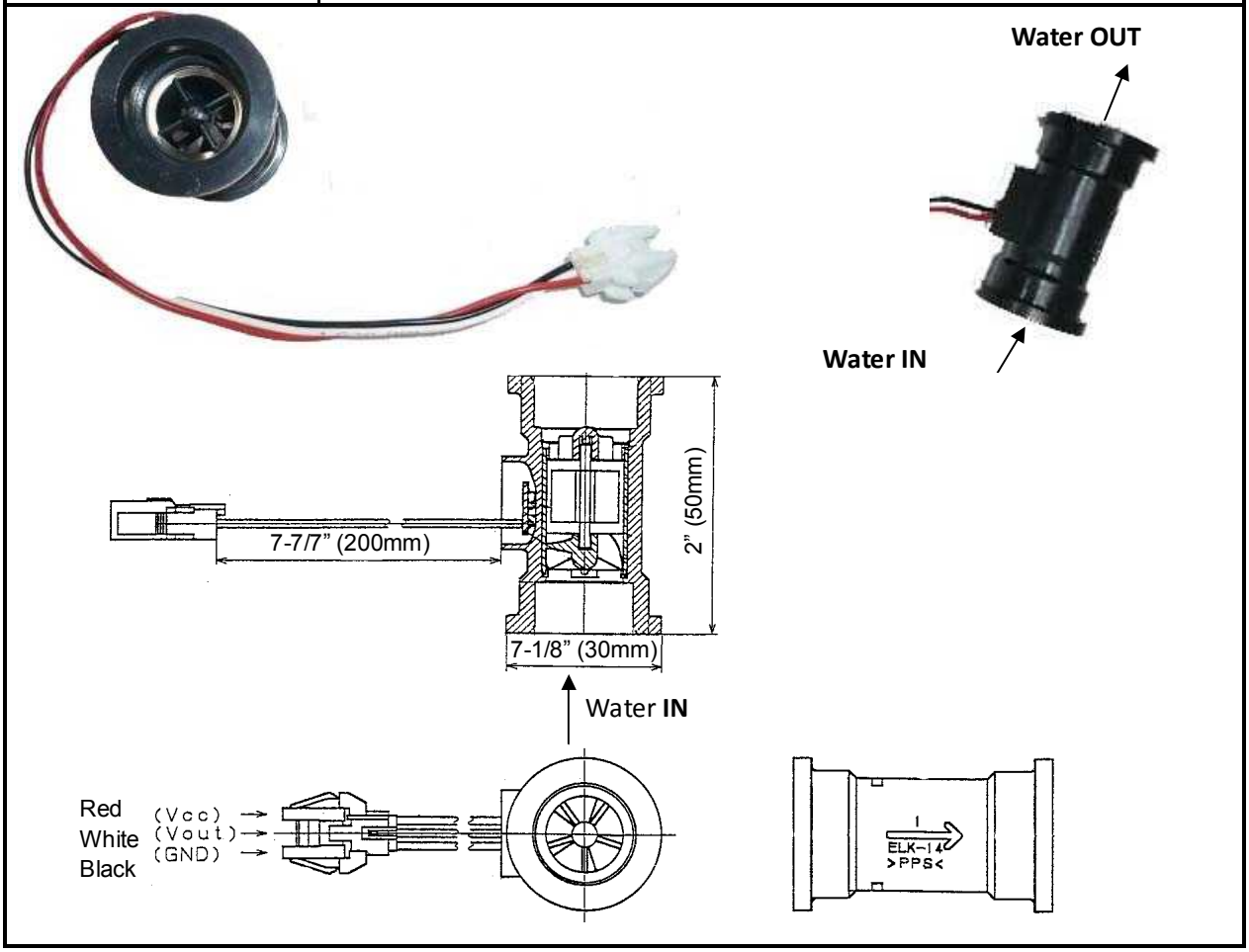
Only the ASME model has a plate as shown in the drawings below. The configuration and material of the ASME model heat exchanger are different from the regular model, as well.

Regular model



10-8. Flow sensor

Unit Part #	#429	**AOS Part #**	EKH33	**Checkpoint**	**H2**
Function	Detects and measures water flow rate using a spinning impeller and magnetic pick-up.				
Failure event	Unable to detect or measure any water flow rate.				
Effects on the water heater if flow sensor fails	Ignition sequence does not start (water heater will not initiate any operation)				
Error codes when the flow sensor fails	**441 (only within Easy-link and Multi-unit systems)**				
Diagnostic	1. Visual inspection: connection /breakage of wires and/or debris on impeller. 2. Check voltages: proper range of values shown below.				
Color / Number of wires	Red - Black	4.0 to 5.5 VDC (Input)			
	White(+)-Black(GND)	1 to 4 VDC (pulse) 1,200 pulse / min (more than 20 Hz)			



10-9. Water control valve (flow adjustment valve and bypass valve)

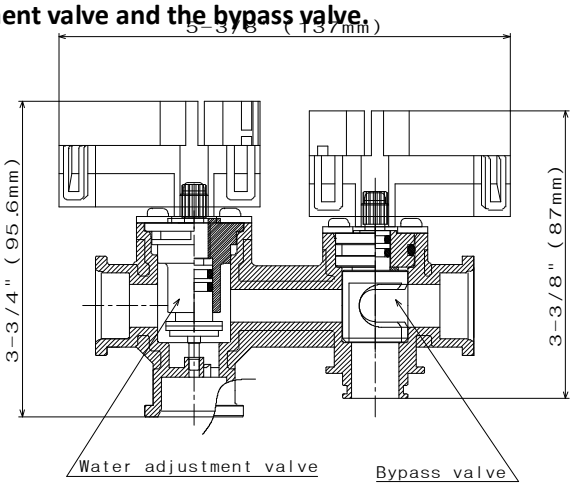
Unit Part #	#423	**AOS Part #**	EKH32	**Checkpoint**	**J**
Function	The water control valve in the water heater has three functions of water control: flow adjustment, bypass, and two-way) This valve is exactly the same as the water valve in the T-M50. Its functions are as follows: 1. Controls water flow to properly control the output hot water temperature. (The function of the flow adjustment valve) 2. Mixes the hot water from the heat exchanger and the cold water from the water inlet to properly adjust the water heater's outlet water temperature. (The function of the bypass valve) 3. Stabilizes the water temperature in the heat exchanger, preventing low-temperature corrosion caused by heat exchanger condensation. (The function of the bypass valve) 4. Prevents water from flowing through the heat exchanger when water heater is not in operation to protect the heat exchanger. (The function of the two-way valve)				
Failure event	1. Water leakage from valve. 2. The valve cannot modulate or make open / close positions.				
Effects on the water heater if water control valve fails	1. Water leakage from failed valve can damage other water heater components. 2. Temperature fluctuations may occur in the hot water output of the water heater, due to inability to modulate water flow. 3. Can cause water to still flow through the heat exchanger when the water heater is not operating, possibly damaging the heat exchanger and causing water leaks.				
Error codes when Water control valve fails	**651**				
Diagnostic	1. Visual inspection: connection / breakage of wires, motor drive locked due to scale buildup, and /or water leakage. 2. Check voltages and resistance; proper range of values shown below.				

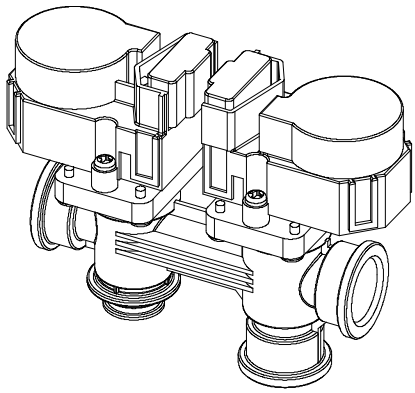
NOTE: Color/Number of wires and pictures are on the following page.

10-9. Water control valve (flow adjustment valve and bypass valve)

Color / Number of wires	Blue-Brown	13.0 to 16.0 VDC
	Orange-Brown	ON: 12.5 to 16.0 VDC OFF: 0 to 1 VDC
	Red-Brown	(0° position) 1 VDC less

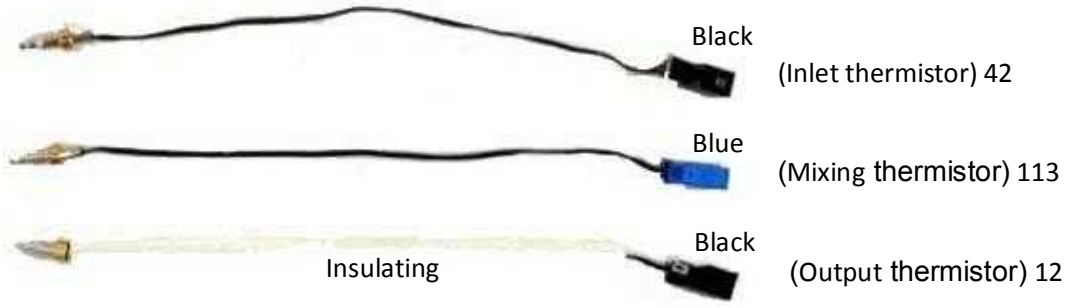
The water control valve contains the flow adjustment valve and the bypass valve.



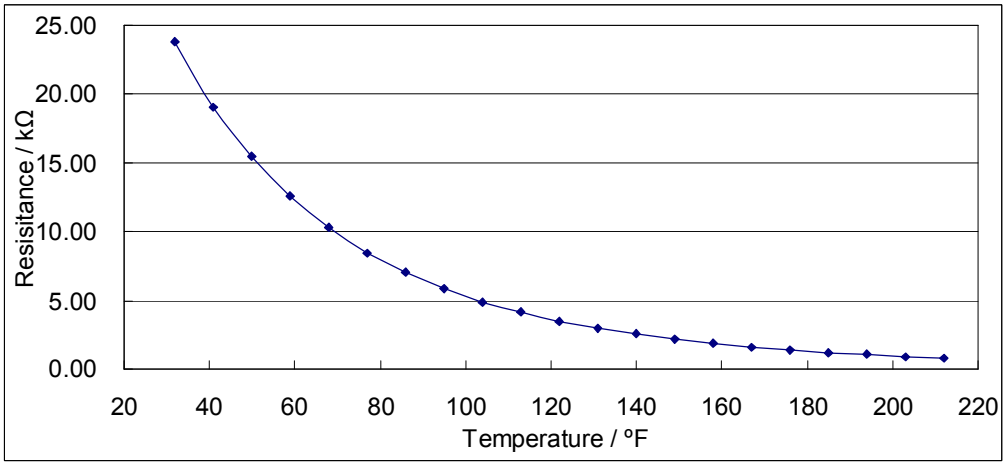


10-10. Thermistors

Unit Part #	#422 (Inlet) #433 (Output) #418 (Mixing)	**AOS Part #**	EKK38 (Inlet) EKK2T (Output) EX00H (Mixing)	**Checkpoint**	**E1 (Mixing)** **E2 (Output)** **E3 (Inlet)**
Function	Measure cold / hot water temperatures in the water heater.				
Failure event	Unable to properly measure water temperatures within the water heater.				
Effects on the water heater if thermistor fails	If the thermistors fail open or short, error code appears before starting operation. If resistance values are just off, water heater will have temperature fluctuations in hot water.				
Error codes when thermistors fails	**311 (Output)**		**321 (Inlet)**		**331 (Mixing)**
Diagnostic	1. Visual inspection: connection / breakage of wires and/or debris on thermistor. 2. Check voltages and resistance; proper range of values shown below.				
Color / Number of wires	Inlet Black (42)-Black		68˚F (20°C) 9.0 to 13 kΩ		
	Output Black (12)-Black		122˚F (50°C) 3.3 to 4.4 kΩ		
	Mixing Black (113)-Black		176˚F (50°C) 1.4 to 1.8 kΩ (see table below for more resistance values)		



Resistance values of thermistors as a function of temperature

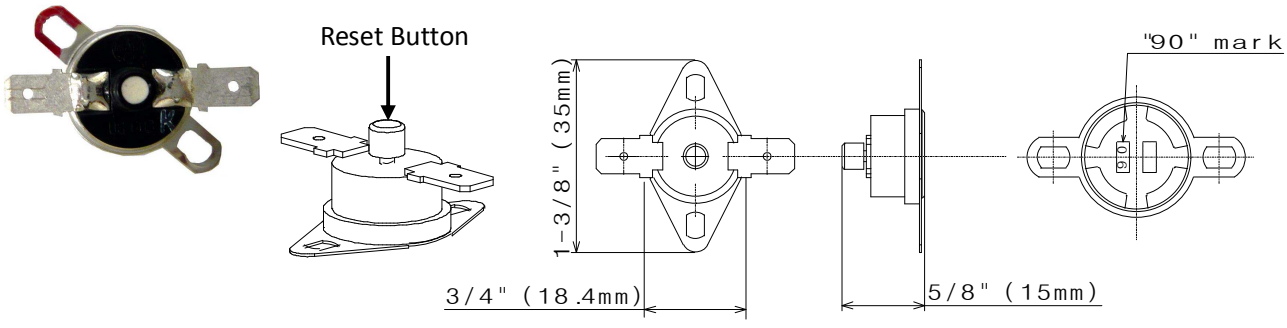


10-11. Hi-limit switch

Unit Part #	#432	**AOS Part #**	EKN34	**Checkpoint**	**C1**
Function	-Based on bi-metal thermal expansion. -Detects excessively high water temperature (more than 194˚F or 90˚C) in pipes of the heat exchanger. -After detection, communication between the computer board and gas valves are severed, shutting down the water heater instantly. The "111" or "121" error codes will display.				
Failure event	1. Unable to detect excessively high water temperatures if switch fails "closed". 2. Continuous detection of excessively high water temperatures (regardless of what the actual water temperature is) if switch fails "open".				
Effects on the water heater if hi-limit switch fails	1. Unable to shut down the water heater if the water temperature from the heat exchanger exceeds 194˚F (90˚C). Note: The mixing and output thermistors always act as backup hi-limit detectors to detect excessively high water temperatures in the heat exchanger. 2. The water heater is always shut down immediately after the ignition process, and either the "111" or "121" error code will display.				
Error codes when hi-limit switch fails	**111** **112** **The T-M32 doesn't have the "141" error code that was used in our previous models. This error code is now replaced by the "111" and the "121" error codes.**				
Diagnostic	1. Visual inspection: connection / breakage of wires. Possibility also includes scale deposits inside the heat exchanger. 2. Check voltages and resistance: proper range of values shown below.				
Color / Number of wires	Blue-Blue Less than 1.0 Ω				

When temperatures exceed 194˚F (90˚C), the reset button trips and switch goes to OFF mode.

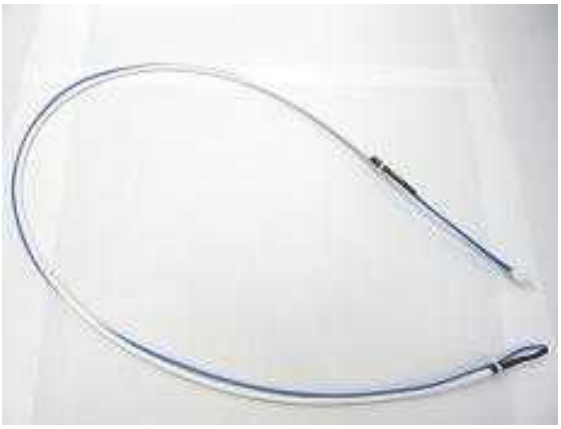
ON mode:<194˚F (90˚C) OFF mode: to reset switch back to ON mode, press the reset button

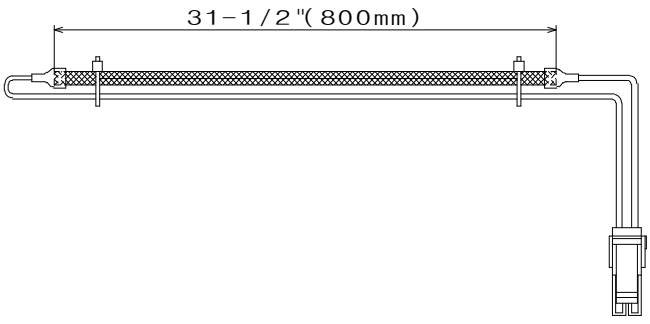


10-12. Overheat cutoff fuse

Unit Part #	#403	**AOS Part #**	EM387	**Checkpoint**	**C2**
Function	The overheat cutoff fuse contains solder with a melting point of 430˚F (221˚C). Detects excessive temperatures within the water heater, especially around the heat exchanger and combustion chamber. Upon detection, communication between the computer board and gas valves will sever, shutting down the water heater instantly. The "111" or "121" error code will display.				
Failure event	1. Unable to detect the excessively high temperatures within the water heater.				
Effects on the water heater if the overheat cutoff fuse fails	1. Flames from burner may penetrate a ruptured/damaged heat exchanger. 2. Gas valves will not operate.				
Error codes when overheat cutoff fuse fails	**111**		**121**		
Diagnostic	1. Visual inspection: connection / breakage of wires. 2. Check voltages and resistance: proper range of values shown below.				
Color / Number of wires	Blue-Blue Less than 1.0 Ω				

Solder will melt at temperature exceeding 430˚F (±9˚F) / 221˚C (±5˚C)



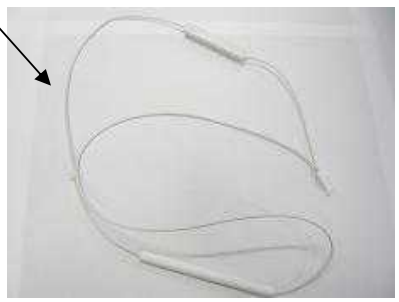


10-13. Freeze protection heaters

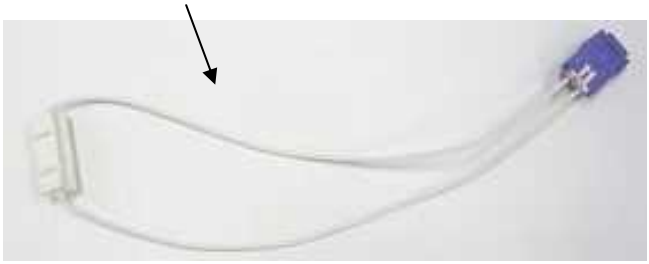
Unit Part #	#404 #410 #415 #426	**AOS Part #**	EKN86 EX002 EKK2P EM45V	**Checkpoint**	**L**
Function	Prevents the heat exchanger, water valves, and water pipes within the water heater from freezing. The heaters are but one of the freeze protection devices in the water heater.				
Failure event	Open circuit failure: ceramic heaters do not receive the voltage needed to heat up.				
Effects on the water heater if heater fails	Ceramic heaters do not activate, allowing water contained in the heat exchanger to freeze up, possibly causing the heat exchanger to burst.				
Error codes when hears fails	**N/A**				
Diagnostic	1. Visual inspection: connection / breakage of wires and the condition of the heaters. 2. Check: whether those are in the normal range as shown in the following table.				
Color / Number of wires	Black - Black 90 to 110 VAC (during freeze protection operation)				

The water heater has four types of the heaters in it. All of them for protecting of the heat exchanger, the water pipes, the water inlet and the water outlet.

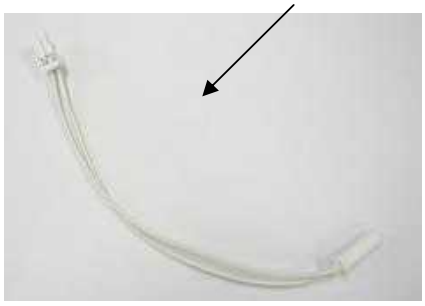
Pipe heater with Block heater (#426 / EM45V)



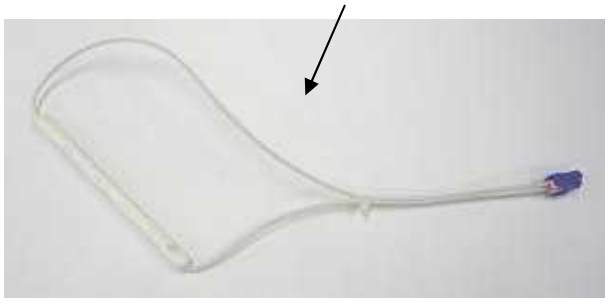
Heater (#410 / EX002)



Inlet heater (#415 / EKK2P)

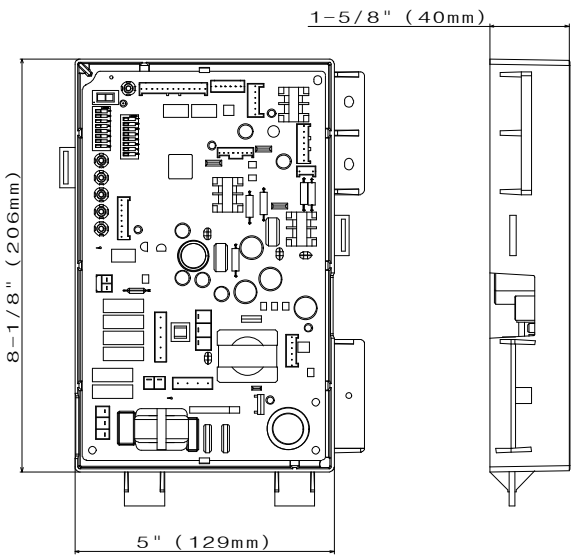


Pipe heater (#404 / EKN86)



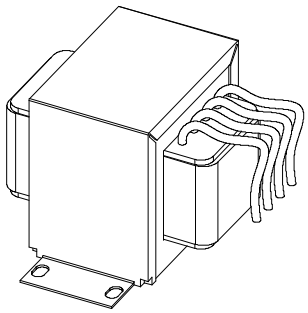
10-14. Computer board

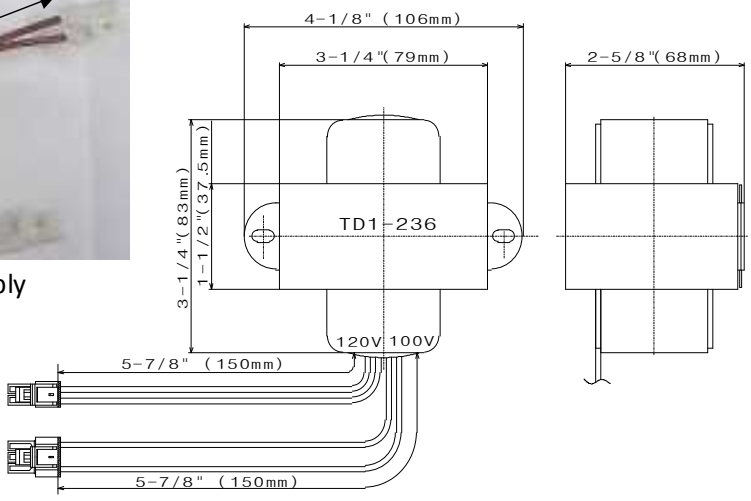
Unit Part #	#701	**AOS Part #**	EM376	**Checkpoint**	**N/A**
Function	Controls the functions of the most parts in the water heater.				
Failure event	Malfunctioning computer				
Effects on the water heater if the computer board fails	When the computer board failed, the control from the computer and/or the multi-system control will be abnormal. The following are the typical examples of when the computers fail: 1. Unable to control proper combustion during operation. 2. Unable to detect correct signals from any/all water heater sensors. 3. Unable to control water valves, which may cause output temperature fluctuations. 4. Errors in its self-diagnostics. In order to self-diagnose properly, the computer sends a low voltage signal into its circuit. When the computer does not detect a return signal, from this circuit, the "701" error code will appear. 5. Unable to communicate to other computers in the water heater models and/or the multi-unit controller (TM-MC01) during the multi-unit system operation.				
Error codes when the computer board fails	**701**	**721**	**741**	**761**	
Diagnostic	Visual inspection: connection / breakage of wires and or burn marks on the computer board.				
Color / Number of wires	**N/A**				



10-15. Transformer

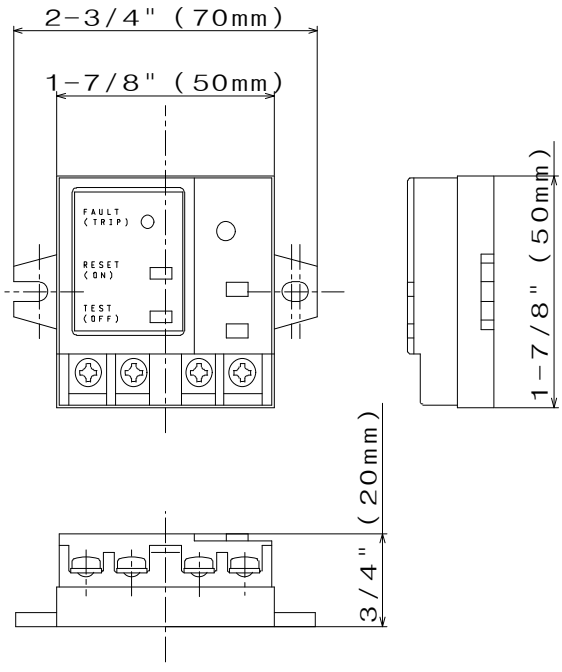
Unit Part #	#702	**AOS Part #**	EM454	**Checkpoint**	**A1,A2**
Function	-To transform input voltage from 120 to 100 VAC. -Every electrical component of the water heater is designed to only work with a 100 VAC power supply, therefore, the T-M32 comes equipped with this transformer.				
Failure event	1. There is no power coming from the transformer. 2. The voltage from the power supply cannot be converted to 100 VAC.				
Effects on the water heater if transformer fails	1. The water heater does not operate due to lack of power from transformer. 2. A failed transformer can cause electrical damage to other electrical components within the water heater.				
Error codes when transformer	**N/A**				
Diagnostic	1. Visual inspection: connection / breakage of wires and/or signs of electrical damage. 2. Check voltages of the transformer: Proper range of values shown below.				
Color / Number of wires	White – Black	120 VAC / less than 1.0 Ω			
	Brown - Brown	100 VAC ±5 / less than 1.0 Ω			

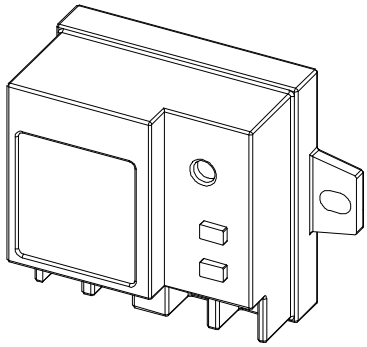




10-16. GFI

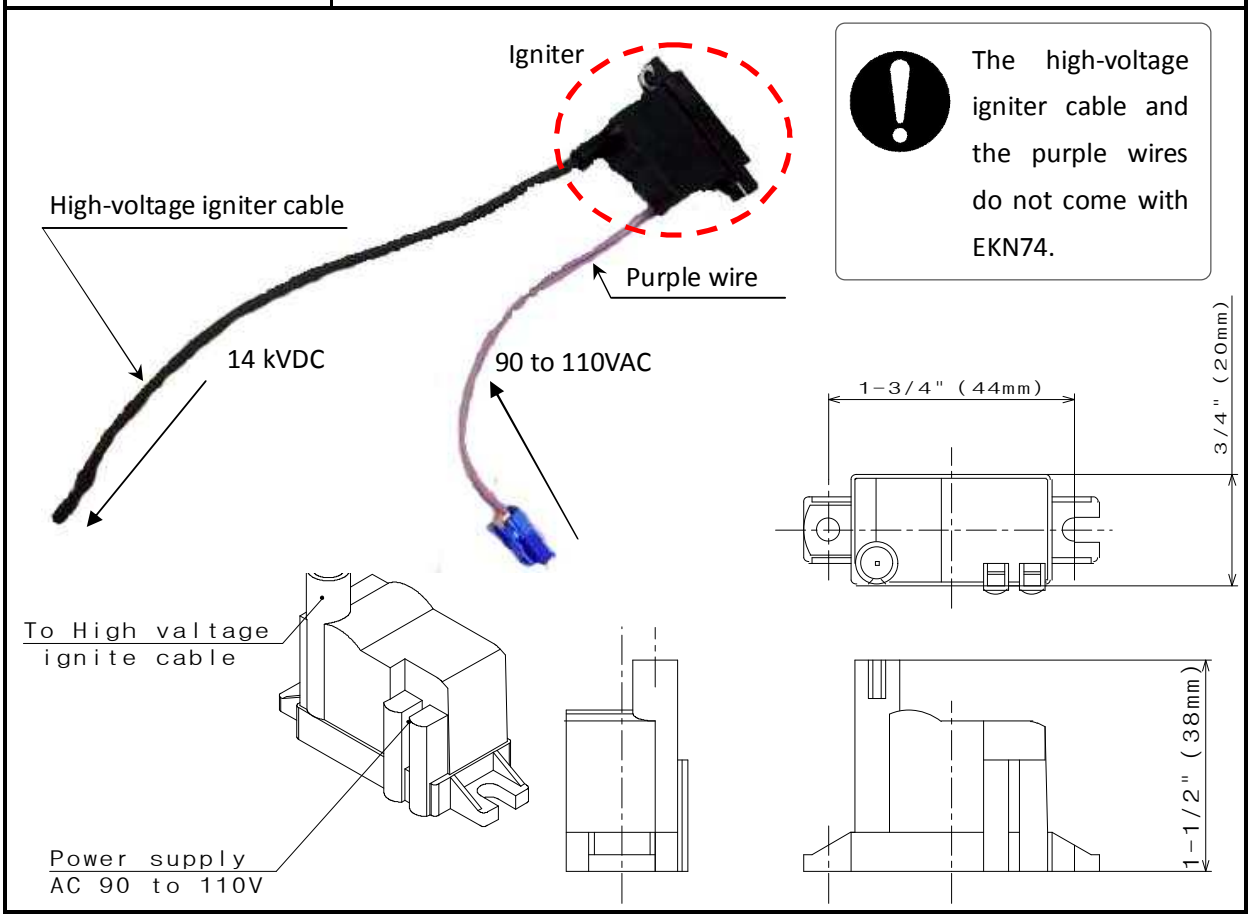
Unit Part #	#712	**AOS Part #**	EM207	**Checkpoint**	**A,A1**
Function	-Detects electrical leakage in the water heater. -Stops providing power to the water heater in the case of electrical leakage.				
Failure event	1. ON-failure: Always in the ON mode (never trips). 2. OFF-failure: Always in the OFF mode (always stays tripped).				
Effects on the water heater if the GFI fails	1. ON-failure: GFI cannot detect electrical leakage within the water heater. 2. OFF-failure: the water heater does not receive any power from the GFI, which means the water heater cannot operate.				
Error codes when the GFI fails	**N/A**				
Diagnostic	1. Visual inspection: connection / breakage of wires and/or some signs of electrical damage on the GFI. 2. Check the power supply to the GFI. If the red LED on the GFI lights up after pressing the "test" button, the GFI is receiving power. After verifying the power supply, verify that 100 VAC is entering and leaving the GFI.				
Color / Number of wires	**N/A**				





10-17. Igniter

Unit Part #	#125	**AOS Part #**	EKN74	**Checkpoint**	**B**
Function	-To ignite the gas / air mixtures when the water heater is ready to burn gas on its burner surface. -The output voltage of the igniter is more than 14 kVDC.				
Failure event	1. Unable to ignite during the ignition process. 2. Makes attempts to ignite at all times.				
Effects on the water heater if the igniter fails	1. The water heater cannot ignite during the ignition process and the "111" or "121" error codes will display. 2. No effects on the water heater, however, the durability of the igniter wears down.				
Error codes when Igniter fails	**111**			**121**	
Diagnostic	1. Visual inspection: connection / breakage of wires and /or an observed weak spark. 2. Check voltages: proper range of values shown below.				
Color / Number of wires	Purple(7)-Purple(7) 90 to 110 VAC				

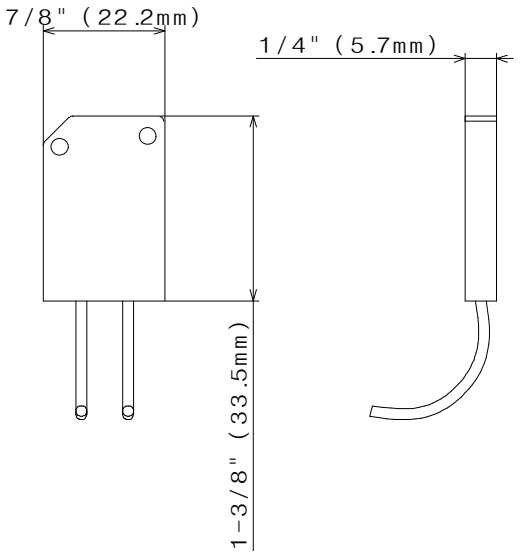


10-18. Freeze protection thermostat

Unit Part #	#117	**AOS Part #**	EKJ59	**Checkpoint**	**L**
Function	Temperature detecting device which prevents the pipes within the water heater from freezing. When this device detects temperatures below 36.5˚F (2.5˚C) inside the water heater, power is supplied to the electric heaters to prevent the water heater from freezing.				
Failure event	1. ON-failure (Always senses freezing temperatures, regardless of actual temperature). 2. OFF-failure (Never senses freezing temperatures).				
Effects on the water heater if the freeze protection thermostat fails	1. The freeze protection heaters will always be ON, causing heat damage to components inside the water heater. 2. The freeze protection heaters will never be able to turn on, even under freezing temperatures, causing freeze damage to the water heater.				
Error codes when the freeze protection thermostat fails	**N/A**				
Diagnostic	1. Visual inspection: connection / breakage of wires and/or the body has been broken. 2. Check resistance and voltage: proper range of values shown below.				
Color / Number of wires	Black - Black (itself)	ON mode: 90 to 110 VAC and less than 1 Ω OFF mode: less than 1 VAC and more than 1 MΩ			

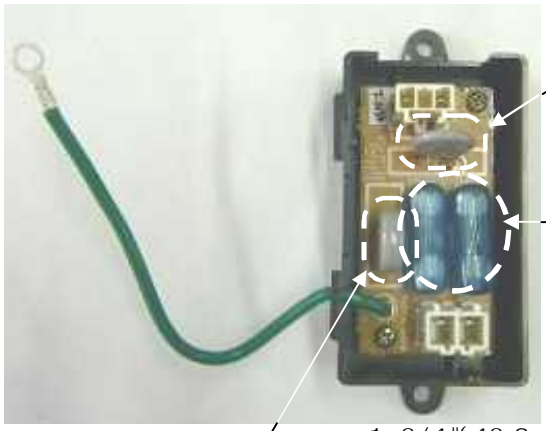
Activation and deactivation temperature of the T-M32's freeze protection system

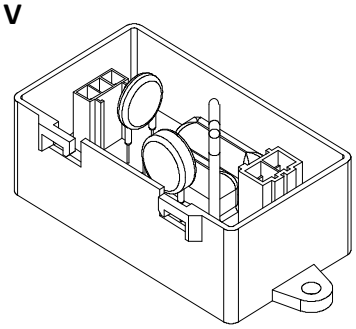
ON mode: 36.5˚F (+6.3˚F -2.7˚F)	2.5˚C (+3.5˚C -1.0˚C)
OFF mode: above 46.4˚F	above 8 ˚C

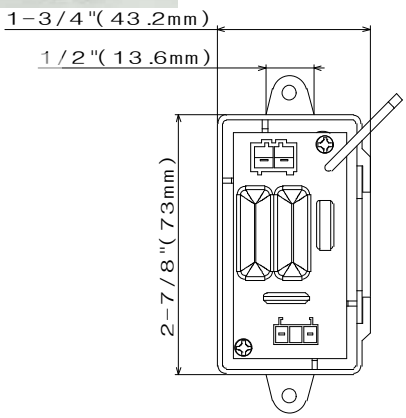


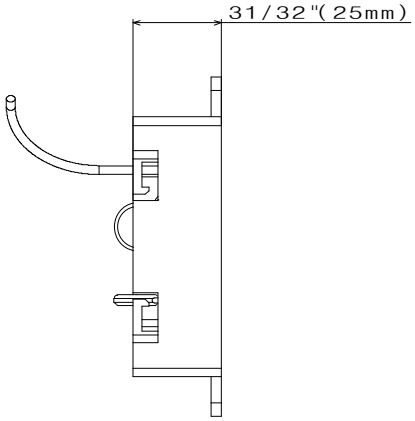
10-19. Surge box

Unit Part #	#715	**AOS Part #**	EM385	**Checkpoint**	**A2,A3**
Function	Protects the unit from high voltage and/or high electric current caused by lightning. There are 2 types of surge absorbers in the water heater Surge absorber A is activated by voltage higher than 220 V, the other one is activated by voltage higher than 680 V.				
Failure event	1. Open-failure of the absorber and/or fuse. 2. Short-failure of the absorber.				
Effects on the water heater if the Surge box fails	1. Unable to protect the computer board if high voltage gets applied to the unit. The computer board can short out, stopping all operations. 2. The unit cannot operate because the absorber shorted out, causing the fuse to break open.				
Error codes when the Surge box fails	**N/A**				
Diagnostic	1. Visual inspection: burn marks on components and/or connection / breakage of wires. 2. Check resistance and voltage: proper range of values shown below.				
Color / Number of wires	White-Black 108 to 132 VAC				









11. Fault Analysis & Specifications

Remarks:
1. Proper range of values of voltage & resistance shown below.
2. Please refer to the wiring diagram for checkpoint positions.
3. Remove power to water heater when checking for continuity, disconnections, resistance values, etc.

Natural of Fault	Diagnosis	Check point
・No display on temperature remote controller, even when remote is turned on.	1 Check the power supply [1] Check the power supply from GFI to the PCB **(Refer to section12-2)** [2] Check the power supply line to the water heater	
	2 Fault of GFI Normal: 100 VAC between (white-black) Normal: 100 VAC between (brown-brown)	 A A1
	3 Fault of transformer [1] Disconnection / breakage of wires Normal: 120 VAC between (white-black) Normal: 100 VAC between (brown-brown)	 A2,A3 A1
	4 Blown fuse at surge box (10 A)	
	5 Fault of PCB [1] No voltage at remote control terminal Normal: 11 to 25 VDC between (white-black)	 F
	6 Disconnection / short-circuit / grounding of remote wires Normal: 11 to 25 VDC between (white-black)	
	7 Fault of PCB of remote control [1] Check for normal voltage at terminal	
・It takes long time to get hot water at the fixtures	1 The time it takes to deliver hot water from the water heater to fixtures depends on the length of piping between them. The longer the distance and/or the bigger the pipes, the longer it will take to get hot water. 2 If you need to receive hot water to fixtures quicker, you may want to consider a hot water recirculation system.	
・The water is not hot enough	1 Check cross pluming between cold water lines and hot water lines. 2 Check whether the gas supply pressure is enough. 3 Check whether the temperature setting is too low.	
・The water is too hot	1 Check whether the temperature setting is too high.	
・The hot water is not available when a fixture is opened	1 Make sure the unit has a 120 VAC / 60 Hz power supply. 2 If the remote controller is used, check whether the power button is turned on. 3 Check that the filter on the cold water inlet is clean. 4 Check whether the hot water fixture is sufficiently open to draw at least 0.5 GM through the water heater.	

Natural of Fault	Diagnosis	Checkpoint
• The hot water is not available when a fixture is opened	5 Check that the filter on the cold water inlet is clean. 6 Check whether or not the unit is frozen. 7 Check if there is enough gas in the tank. (for propane units)	
•The hot water turns cold and stays cold	1 Check whether the flow rate is high enough to keep the water heater running. 2 Check if there is a recirculation system installed and check also if the recirculation line has enough check valves. 3 Check that the filter on the cold water inlet is clean. 4 Check that the fixtures are free from debris and obstructions.	
• The fan motor is still spinning after operation has stopped	1 This is normal operation. After operation has stopped, the fan motor keeps its running for 35 seconds in order to re-ignite quickly, as well as purge all the exhaust gas out of the flue.	
• Abnormal sound from water heater	1 Check the gas type of the water heater. 2 Check how long the water heater has been installed and in use. 3 Check the installation place. 4 Check the altitude / elevation of area of where the water heater installed. 5 Check the vent length, when the water heater has been installed indoors. 6 Check the type of vent cap, when the water heater has been installed outdoors. 7 Check if there is any blockage in the intake air and/or exhaust. 8 Check if there is dust and lint in burner and heat exchanger, when the water heater has been installed in laundry room. 9 Check if there is grease and dirt in burner and fan motor, when the water heater has been installed in restaurant. 10 Check the manifold pressure in the water heater.	

Natural of Fault	Malfunction description	Cancellation method
• Fluctuation of hot water temperature	-Fault of gas solenoid valves (SV_1 & SV_3) during change of the combustion stage -Fault of flow adjustment valve	
	Diagnosis	**Checkpoint**
	1 Check whether the filter in cold water inlet is cleaned. 2 Check whether the gas supply pressure is adequate. 3 Check for cross connections between cold water lines and hot water lines.	

Natural of Fault	Diagnosis	Checkpoint
• Fluctuation of hot water temperature	4 Fault of PCB in the water heater [1] No voltage to gas solenoid valve (SV_1). Normal: 78 to 100 VDC between COM (blue) & #9 (green) (during operation) [2] No voltage to gas solenoid valve (SV_3). Normal: 78 to 100 VDC between COM (blue) & #73 (red) (during operation)	C
	5 Gas solenoid valve (SV_1) fault [1] Disconnected wiring to gas solenoid valve (SV_1) Normal: 1.3 to 1.9 kΩ between COM (blue) & #9 (green) [2] Disconnected wiring to gas solenoid valve (SV_3) Normal: 0.9 to 1.7 kΩ between COM (blue) & #73 (red)	C
	6 Fault of PCB in the water heater No voltage to water control valve Normal: 13.0 to 16.0 VDC between (blue-brown) Normal: ON 12.5 to 16.0 V / OFF 0 to 1 V between (orange-brown) Normal: DC 1 V less (0˚ position) between (red-brown)	J
	7 Fault of Water control valve Normal: 0.09 to 0.2 kΩ between (red-black)	J

Error Code	Malfunction description	Cancellation method
031	Incorrect dipswitch setting fault	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	Check the dipswitch settings on all PCBs	

Error Code	Malfunction description	Cancellation method
101	Warning for the “991” error code **(Refer to section 12-3)**	On the PCB, press the INC and DEC buttons simultaneously for 3 sec. Then turn the power off.
	Diagnosis	**Checkpoint**
	1 Check the gas type of the water heater. 2 Check how long the water heater has been installed and in use. 3 Check the installation location. 4 Check the altitude / elevation of area of where the water heater installed. 5 Check the vent length, when the water heater has been installed indoors. 6 Check the type of vent cap, when the water heater has been installed outdoors. 7 Check if there is any blockage in the intake air and/or exhaust.	

Error Code	Diagnosis	Checkpoint
101	8 Check if there is dust and lint in burner and heat exchanger, when the water heater has been installed in laundry room. 9 Check if there is grease and dirt in burner and fan motor, when the water heater has been installed in restaurant. 10 Check the manifold pressure in the water heater.	

Error Code	Malfunction description	Cancellation method
111 Error code is shown after three failed attempts at iginition	Ignition failure	Turn off the power or water supply

Diagnosis	Checkpoint
1 Check gas supply and inlet gas pressure **(Refer to section 1)**	
2 Check the igniter **(Refer to section 10-17)** Visual inspection: connection / breakage of wires and/or observed weak spark. [1] Cracks / soot on igniter rod [2] Improper gap between burner & igniter rod Normal gap: 0.16" (4mm) [3] PCB fault Normal: 90 to 110 VAC at #7 (purple-purple) (during ignition)	B
3 PCB fault [1] No voltage to main gas solenoid valve (MV) Normal: 78 to 100 VDC between COM (blue) & #3 (light blue) (during operation) [2] No voltage to gas solenoid valve (SV_2) Normal: 78～100 VDC between COM (blue) & #53 (orange) (during operation) [3] No voltage to gas proportional valve (VG_0) Normal: 1～15 VDC between white & red (during operation)	C H1
4 Gas solenoid valve fault [1] Main gas solenoid valve (MV) fault Normal: 0.9 to 1.3 kΩ between COM (blue) & #3 (light blue) [2] Gas solenoid valve (SV_2) fault Normal: 1.3 to 1.9 kΩ between COM (blue) & #53 (orange) [3] Gas proportional valve (VG_0) fault Normal: 1 to 15 VDC between white & red (during operation)	C H1
5 Disconnected / damaged O.H.C.F. **(Refer to section 10-12)** Visual inspection: connection / breakage of wires. Normal: 1 Ω or less between blue & blue	C2

Error Code	Diagnosis	Checkpoint
111 Error code is shown after three failed attempts at ignition	6 Disconnected / damaged hi-limit switch. **(Refer to section 10-11)** Visual inspection: connection / breakage of wires. Normal: 1 Ω or less between blue & blue	C1
	7 Inspect flame rod [1] Check for any soot on the rod. [2] Check the connection of ground wire; make sure there is firm contact to the ground of the water heater. (in this case, the wire is contacted to the manifold surface.) [3] PCB fault During operation: more than 1 μA through the flame rod wire (orange) [4] Flame rod fault During operation: more than 1 μA through the flame rod wire (orange)	I
	8 Check if hi-limit switch is properly functioning.	

Error Code	Malfunction description	Cancellation method
121 Error code is shown after three failed attempts at ignition	Loss of flame	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 Check gas supply and pressure **(Refer to section 1)**	
	2 PCB fault [1] No voltage to gas main solenoid valve (MV) Normal: 78 to 100 VDC between COM (blue) & #3 (light blue) (during operation) [2] No voltage to gas solenoid valve (SV_2) Normal: 78 to 100 VDC between COM (blue) & #53 (orange) (during operation) [3] No voltage to gas proportional valve (VG_0) Normal: 1 to 15 VDC between white & red (during operation)	C H1
	3 Gas solenoid fault [1] Main gas solenoid valve (MV) fault Normal: 0.9 to 1.3 kΩ between COM (blue) & #3 (light blue) [2] Gas solenoid valve (SV_2) fault Normal: 1.3 to 1.9 kΩ between COM (blue) & #53 (orange) [3] Gas proportional valve (VG_0) fault Normal: 1 to 15 VDC between white & red (during operation)	C H1
	4 Check for soot on the flame rod [1] Clean the flame rod [2] PCB fault During operation: more than 1 μA through the flame rod wire (orange)	I

Error Code	Diagnosis	Checkpoint
121 Error code is shown after three failed attempts at ignition	5 Disconnected / damaged O.H.C.F. **(Refer to section 10-12)** Visual inspection: connection / breakage of wires. Normal: 1 Ω or less between blue & blue	C2
	6 Check if hi-limit switch is properly functioning.	
	7 Disconnected / damaged hi-limit switch. **(Refer to section 10-11)** Visual inspection: connection / breakage of wires. Normal: 1 Ω or less between blue & blue	C1

Error Code	Malfunction description	Cancellation method
311	Disconnected / short-circuited output thermistor	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 Output thermistor fault **(Refer to section 10-10)** Visual inspection: connection / breakage of wires and/or debris on thermistor. Check voltage / resistance between black & black (#12). Refer to Section 8 for proper range of values.	E2

Error Code	Malfunction description	Cancellation method
321	Disconnected / short-circuited inlet thermistor	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 Inlet thermistor fault **(Refer to section 10-10)** Visual inspection: connection / breakage of wires and/or debris on thermistor. Check voltage / resistance between black & black (#42). Refer to Section 8 for proper range of values.	E3

Error Code	Malfunction description	Cancellation method
331	Disconnected / short-circuited mixing thermistor	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 Mixing thermistor fault **(Refer to section 10-10)** Visual inspection: connection / breakage of wires and/or debris on thermistor. Check voltage / resistance between black & black (#113). Refer to Section 8 for proper range of values.	E1

Error Code	Malfunction description	Cancellation method
391	Disconnected AFR rod	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 AFR rod fault **(Refer to section 10-6)** Visual inspection: connection / breakage of wires, soot on it.	I

Error Code	Malfunction description	Cancellation method
441	Flow sensor failure (Only Easy-link and Multi-unit system)	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 Flow sensor failure **(Refer to section 10-8)** Visual inspection: connection/ breakage of wires andor debris on impeller. Check voltage / resistance between (red & black) or (white & black)	H2

Error Code	Malfunction description	Cancellation method
510	Fault of driving circuit for main gas solenoid valve (MV) (The computer checks the condition of the main gas valve immediately after every operation)	Turn off the power supply
	Diagnosis	**Checkpoint**
	1 PCB and /or main gas valve fault **(Refer to section 10-4 & 10-14)** Visual inspection of gas valves: connection / breakage of wires. Normal: 78 to 100 VDC between COM (blue) & #3 (light blue) (during operation) Visual inspection of PCB: connection / breakage of wires and/or burn marks on the computer board. 2 Main gas valve fault	C

Error Code	Malfunction description	Cancellation method	
551	Fault of driving circuit for any of the gas solenoid valves (SV_1, SV_2, and/or SV_3) (The computer checks the condition of the solenoid valves 6 hours after every operation)	Turn off the power supply	
	Diagnosis		**Checkpoint**
	1 PCB and /or gas valve fault **(Refer to section 10-4 & 10-14)** Visual inspection of gas valves: connection / breakage of wires. Normal: DC78 to 100 VDC between COM (blue) & #9 (green) (during operation) Normal: DC78 to 100 VDC between COM (blue) & #53 (orange) (during operation) Normal: DC78 to 100 VDC between COM (blue) & #73 (red) (during operation) Visual inspection of PCB: connection/breakage of wires and/or burn marks on the computer board. 2 Gas solenoid valve fault (SV_1, SV_2, and/or SV_3)		C

Error Code	Malfunction description	Cancellation method	
611	Fault motor fault	Turn off the power or water supply	
	Diagnosis		**Checkpoint**
	1 PCB and fan motor fault **(Refer to section 10-3 & 10-14)** Visual inspection of fan motor: connection / breakage of wires or dust buildup (causing electrical shortage) Normal: 110 to 160 VDC between red & blue (during operation) Normal: 13 to 17 VDC between yellow & blue (during operation) Normal: 2.0 to 6.5 VDC between orange & blue (during operation) Verify fan motor speed of the water heater using the "diagnostics mode" of the temperature remote controller. See the "12-1. How to diagnose the water heater using the temperature remote controller." Visual inspection of PCB: connection / breakage of wires and /or burn marks on the computer board.		G

Error Code	Malfunction description	Cancellation method
631	Pump failure	Turn off the power
	Diagnosis	**Checkpoint**
	1 Check whether the pump connected to PCB works properly.	

Error Code	Malfunction description	Cancellation method
651	Water control valve fault (Flow adjustment function) (Only Easy-link and Multi-unit system)	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 PCB and flow adjustment valve fault **(Refer to section 10-9 & 10-14)** Visual inspection of Water control valve: connection / breakage of wires, motor drive locked due to scale buildup, and/or water leakage. Normal: 13.0 to 16 VDC between (blue-brown) Normal: ON:12.5 to 16.0 VDC / OFF: 0 to 1 V Normal: 1 V Less than (0˚ position) Visual inspection PCB: connection / breakage of wires and/or burn marks on the computer board.	J

Error Code	Malfunction description	Cancellation method
661	Water control valve fault (Bypass valve function)	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 PCB and bypass valve fault **(Refer to section 10-9 & 10-14)** Visual inspection of Water control valve: connection / breakage of wires, motor drive locked due to scale buildup, and/or water leakage. Normal: 13.0 to 16 VDC between (blue-brown) Normal: ON:12.5 to 16.0 VDC / OFF: 0 to 1 V Normal: 1 V Less than (0˚ position) Visual inspection PCB: connection/ breakage of wires and/or burn marks on the computer board.	J

Error Code	Malfunction description	Cancellation method
701	1 PCB fault [1] Fault of preparation for the mixing thermistor operation. [2] Fault of driving circuit for Gas Proportional Valve(VG_0)	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 Check the PCB and /or gas proportional valve **(Refer to section 10-4 &10-14)** Visual inspection PCB: connection / breakage of wires andor burn marks on the computer board. Visual inspection gas proportional valve: connection / breakage of wires of the gas proportional valve. Normal: 20 to 40 Ω between (white) & (red)	H1

Error Code	Malfunction description	Cancellation method
721	False flame detection	Turn off the power or water supply
	Diagnosis	**Checkpoint**
	1 False flame detection (5 sec.) Flame rod (Insulated resistance) fault	I

Error Code	Malfunction description	Cancellation method
741	Miscommunication between water heater and remote controller	Restoring proper cable connections between the water heater and the Remote controller. When the computer detects proper connections between the water heater and the remote controller, "741" error code will cease to display.
	Diagnosis	**Checkpoint**
	1 Temperature remote controller or PCB fault 2 Check for signs of power surges.	

Error Code	Malfunction description	Cancellation method
761	Miscommunication between Parent and Child units for Easy-Link systems or Multi-Unit system.	Restoring proper cable connections between all the T-M32's and the multi-unit controller (TM-MC01). When the computer detects proper connections between the multi-unit controller and the units (water heater), "761" error code will cease to display.
	Diagnosis	**Checkpoint**
	1 Inspect cable connections between Parent and Child units. 2 Inspect cable connections between Multi-unit controller and water heaters. 3 Check for signs of power surges.	

Error Code	Malfunction description	Cancellation method
991	Abnormal burning **(Refer to section 12-3)**	Turn off the power or water supply If not possible, press and hold the INC and DEC buttons on the computer board simultaneously for more than 3 sec.
	Diagnosis	**Checkpoint**
	1 Check the gas type of the water heater. 2 Check how long the water heater has been installed and in use. 3 Check the installation place. 4 Check the altitude / elevation of area of where the water heater installed. 5 Check the vent length, when the water heater has been installed indoors. 6 Check the type of vent cap, when the water heater has been installed outdoors. 7 Check if there is any blockage in the intake air and/or exhaust. 8 Check if there is dust and lint in burner and heat exchanger, when the water heater has been installed in laundry room. 9 Check if there is grease and dirt in burner and fan motor, when the water heater has been installed in restaurant. 10 Check the manifold pressure in the water heater.	

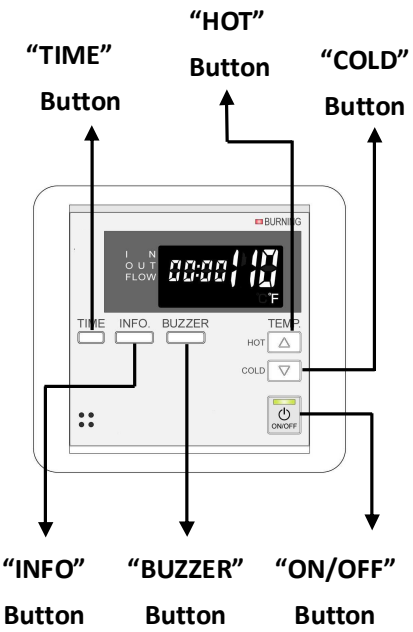
12. Controls and settings

12-1. Diagnosis using the remote controller..... 47
12-2. The error-call button: Verifying functionality of computer board, Displaying error code history, and Clearing error code history memory..... 50
12-3. Clearing the “101” and “991”error code..... 51
12-4. AFR rod function..... 52
12-5. Dipswitch settings..... 53
12-6. Assigning unit numbers in the Easy-link system..... 55
12-7. (A) ON / OFF conditions: Overview..... 56
12-7. (B) ON / OFF conditions: BTU requirements..... 57
12-8. (A) Pump control ON / OFF Condition (Only for single and Easy-link system)..... 58
12-8. (B) Pump control ON / OFF Conditions: BTU requirements for Re-circulation mode..... 59
12-9. Multi-unit system ON / OFF conditions..... 60
12-10. Operation time for unit rotation..... 62
12-11. Individual unit operation in multiple-system while the multi-unit controller (TM-MC01) is under abnormal conditions (Individual operation mode)..... 63
12-12. High Altitude Region Support Software (FM+ and INPUT-)..... 64
12-13. Checking the Flow Rate by Computer Board..... 65
12-14. Relay selection for the pump control connection..... 66
12-15. Adjusting manifold gas pressure..... 67
12-16. Manually adjusting the fan motor speed..... 69
12-17. Freeze protection system..... 70
12-18. Freeze protection for recirculation systems..... 72
12-19. Draining the unit and cleaning the inlet water filter..... 74

12-1. Diagnosis using the remote controller

<Individual unit>

1. Press the "**HOT**" button and the "**COLD**" button simultaneously for at least 5 seconds to enter “Diagnostic mode”.
2. Scroll up or down to the needed information (mode #) of the T-M32 by pressing the “**HOT**” or “**COLD**” buttons.
   (Fig.1 shows mode #5 being selected.)
   When selecting information, please refer to the table on p.49 for the proper mode #.
3. Press the “**INFO**” button to fix the mode #, and the information to which the mode # correlates to will display on the remote controller. (Fig.3)
4. When the “**ON / OFF**” button is pressed or 5 minutes have elapsed without pressing any buttons, the display will return to normal.



Mode #

Fig.1

Information

Fig.2

< For multiple units in the Multi-unit system and the Easy-Link system >

1. Press and hold the "**HOT**" and "**COLD**" buttons simultaneously for at least 5 seconds to enter "Diagnostics Mode".
2. "0" will be displayed on the remote controller. (See Fig. 1)
3. Scroll to the desired T-M32 unit # in the multi-unit system or the easy-link system by pressing the "**HOT**" or the "**COLD**" buttons to scroll up or down.

NOTE: The definition of the unit #'s:

"0" will yield information about the Multi-unit system or the Easy-link system as a whole, and numbers "1", "2", "3"… "20" will yield information about each of the individual T-M32's installed in the Multi-unit system and Easy-link system.

In the Multi-unit system T-M32, a maximum of twenty units can be linked together. For the Easy-link system, a maximum of four units can be linked as well.

4. Press the "**INFO**" button to fix the desired unit #.
5. When the desired unit # is fixed (Fig. 2 shows that unit #10 is being fixed), scroll up or down to the needed information (mode #) of the unit by pressing the "**HOT**" or "**COLD**" buttons. (Fig.3 shows mode #6 is being selected.) **When selecting information, please refer to the table on p.49 for the proper mode #.**
6. Press the "**INFO**" button to select the mode #, and information to which the mode # correlates to will display on the remote controller. (Fig4)
7. When the "**ON/OFF**" button is pressed or 5 minutes have elapsed without pressing any buttons, the display will return to normal.

Whole diagnostic mode | Unit # | Mode# | Information

Fig.1 Fig.2 Fig.3 Fig.4

For example, the figures above show how to arrive at the mixing temperature information for Unit #10 in a Multi-Unit System.

Description of mode numbers in “Diagnostics Mode”

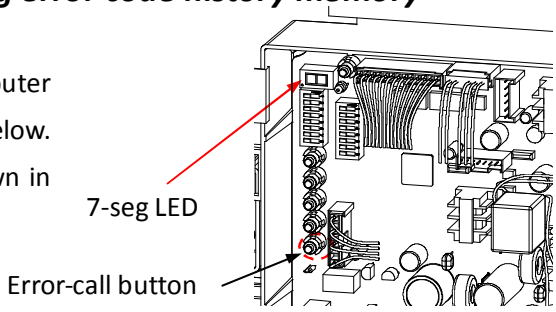
Mode #	Whole multi-unit system information (#0)		Unit information (#1 to #20)	
1	Total system rate	0 to 9,999 (×0.1 GPM)	Total operation time	0 to 9,999 (×10 hours)
2	N/A		ON/OFF cycles	0 to 9,999 (×100 times)
3	Quantity of connected T-M32’s	0 to 20 (units)	Fan motor speed	0 to 9,999 (rpm)
4	Priority T-M32 number	0 to 20	Inlet temperature	32 to 210 (°F) Over 210°F =E5 Under 32°F =E0
5	Quantity of operational T-M32’s	0 to 20 (units)	Output temperature	
6	Set temperature	100 to 185 °F	Mixing temperature	
7	Operation time during current rotation	0 to 999 (minutes)	Air-Fuel ratio rod current	0 to 999 (×0.1μA)
8	ON/OFF cycles during current rotation	0 to 999 (times)	Flow rate	0 to 999 (×0.1 GPM)
9	N/A		Bypass valve position	0 to 9,999, closed position = 0
10**			Ratio of hot water and cold water	0 to 999 (%)
11**			Error code history: displays most recent error code	
12**	Inlet temperature of the priority unit	0 to 999 °F	Error code history: displays 2nd most recent error code	
13**	Mixing temperature of the priority unit	0 to 999 °F	Error code history: displays 3rd most recent error code	
14**	N/A		Clears memory in error code history*	
15**			N/A	
16**			Air-Fuel ratio stage	0 to 16, Normal condition = 6
26			Current value of Proportional valve	0 to 9,999 (×0.1μA)
27			The number of Combustion stages (T-M32 has 4 stages for combustion.)	“1” means 1st stage “2” means 2nd stage “3” means 3rd stage “4” means 4th stage “0” means No burning
28			Energization time of Unit	0 to 9,999 (×10 hour)
29			Estimated output from Computer board	0 to 9,999 (×100 BTU)
30			Actual output of Unit	0 to 9,999 (×100 BTU)
31			Integrating flow of Unit	0 to 9,999 (×1000 gallon)
32			Integrating output of Unit	0 to 9,999 MBTU/h

* Simultaneously press the “**INFORMATION**” button and the “**BUZZER**” buttons on the remote controller while in mode# 14 for at least 5 seconds to completely clear the memory in the error code history.

** Mode #’s after #9 will be displayed as a number (e.g. “10”, “11”,……, “16”) on the remote controller. After #16, the remote controller will cycle back to #1 again.

12-2. The error-code button: Verifying functionality of computer board, Displaying error code history, and Clearing error code history memory

The T-M32 has the "**Error-call button**" on the computer board that provides three main functions listed below. The button is located next to the 7-seg LED (as shown in the picture to the right).

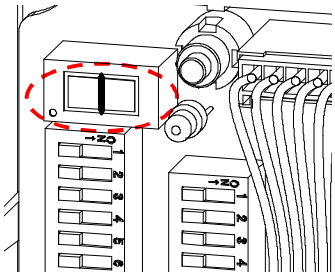


A. Check if the computer board works properly

1. Turn on the ON/OFF button of remote controller.
2. If the computer board works properly, the 7-seg LED will light in a circular "0" pattern, one segment at a time.

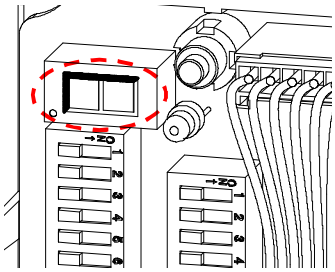
B. Displaying error code history

1. Briefly press the "**Error-call button**" (do not hold down the button).
2. If the T-M32 has had prior error codes, the 7-seg LED will display the most recent error code first. Pressing the button again will display the 2nd most recent error code and so on (Computer saves a maximum of 12 error codes). If the T-M32 has never had any error codes, the 7-seg LED will display a bar "—".



C. Clearing error code history memory

1. Press and hold the "**Error-call button**" for at least 5 seconds.
2. The 7-seg LED will display "C", "L" and "r" in succession to signify that the computer board memory has been erased of all error codes.



12-3. Clearing the "101" and "991" error code

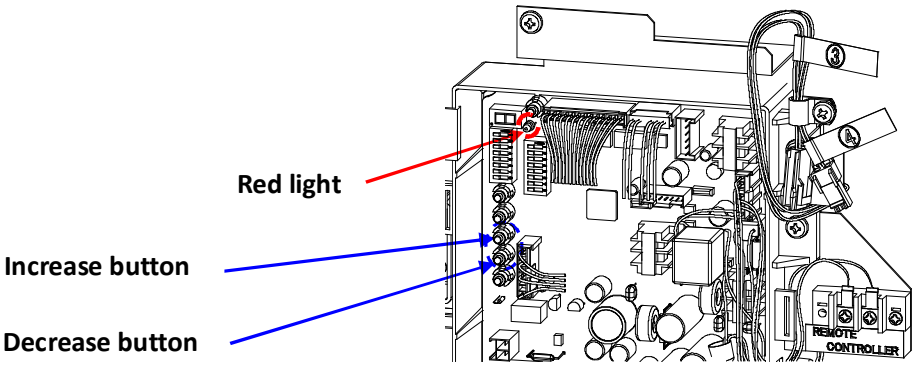
The "101" and "991" error codes signify imperfect (abnormal) combustion, caused by insufficient intake air and/or obstructions in the exhaust.

A. **If the "101" and "991" error code occurs, please check the following:**

1. What is the water heater models gas-type: liquid propane or natural gas?
2. How long has the water heater been installed and been in use?
3. Where is the water heater installed: indoor, outdoor, attic, etc?
4. What is the altitude / elevation of the area of installation?
5. If installed indoors, how long is the vent length?
6. If installed outdoors, what type of vent cap is used?
7. Are there any obstructions in the intake air and/or exhaust?
   - Damper sticking.
   - Vent Flaps installed on the Terminator.
   - Snow build up around Terminator.
   - Installed in a closet. (No Ventilation or lack of combustion air)
8. If installed in laundry room, check the burner and heat exchanger. Dust and lint may deposit in burner and heat exchanger.
9. If installed in restaurant, check the burner and fan motor. Grease and dirt may deposit in burner and fan motor.
10. Check if the manifold pressure of the water heater is too high.

B. How to clear the "101" and "991" error code (after resolving the main root cause of the error):

On the computer board, press and hold the **"Increase"** or **"Decrease"** buttons simultaneously for at least 3 seconds until the red light turns on. Then press reset button on the GFI. The "101" and "991" error code should then be cleared.



12-4. AFR rod function

<Function>

The AFR rod checks flame conditions during combustion. When the AFR rod detects unexpected flame conditions, the computer board of the T-M32 adjusts the fan motor speed to ensure that air and fuel are always at a proper mixture ratio, minimizing emissions.

<AFR normal range of values> (Unit: µA)

Gas type		LPG			Natural gas		
Installation		Outdoor	Indoor	Direct vent	Outdoor	Indoor	Direct vent
Combustion mode	MAX	2 to 18	2 to 19	2 to 17	4.5 to 22	4 to 22	4 to 22
	MIN	1.6 to 23	1.5 to 23	1.4 to 22	1.4 to 18	1.4 to 18	1.4 to 16

- If the AFR value is higher than the normal value, the FM speed is increased.
- If the AFR value is lower than the normal value, the FM speed is decreased.
- Measure the values after burning the water heater for ten minutes.
- **These values are read with the front cover close**.

*The AFR stage can be confirmed in “Diagnostic Mode”. (Section 12-1)

<The relationship between the AFR stage and the “101” and “991” error codes>

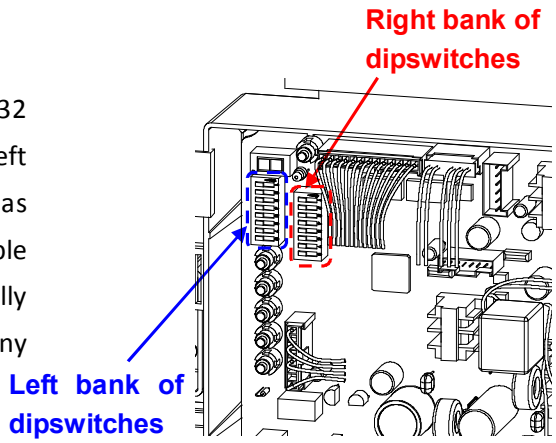
FM	Stage	
+15%	16	“991” error code
+13.5%	15	“101” error code
	⋮	
0%	6	Default condition
	⋮	
-9%	0	

(Condition of AFR stage)

- 0 to 5: Air-rich
- In order to solve the “air excess” problem, the fan motor speed is automatically decreased and AFR combustion stage goes down.
- 6: Default
- 7 to 16: Gas-rich or Air shortage
- In order to solve the “air deficiency” problem, the fan motor speed is automatically increased and AFR combustion stage goes up.
- 15: “101” error code
- 16: “991” error code
- When the “101” or “991” error code appears, see section 12-3.

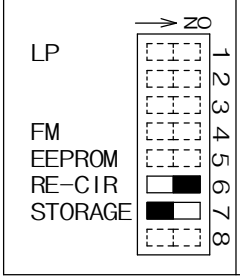
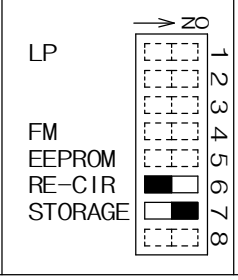
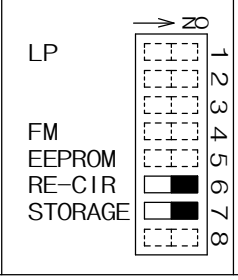
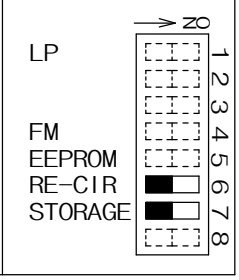
12-5. Dipswitch settings

The T-M32 shares the computer board with the T-M32 ASME. There are two banks of dipswitches (right and left bank) on the T-M32 computer board. The right bank has certain special functions as shown on the following table and generally should not need adjustment. Carefully verify the functions of each dipswitch before changing any settings.



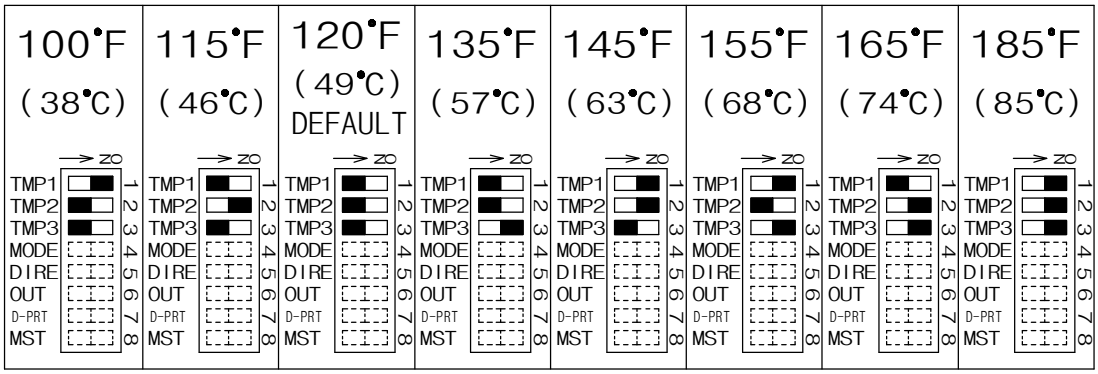
The functions of the right dipswitch bank

No.	Functions	ON position	OFF position
1	Gas type	Propane	Natural gas
2	FM+ (FM speed is increased automatically. See section 12-12)	+7.5% FM-speed	Disable (Default)
3	INPUT- (Maximum gas input is reduced automatically. See section 12-12)	-10% Maximum input	Disable (Default)
4	Allow adjustments of fan motor speed **(Changing the FM speed is similar to changing the manifold pressure. See section 12-16)**	Enable	Disable (Default)
5	Allow access to operation history **(This switch is for a specialized purposes only, and therefore, should not be used)**	EEPROM data transfer	Disable (Default)
6 7	Pump mode		
8	Activation of the fan motor freeze protection system	Enable	Disable (Default)

Recirculation Control	Storage Tank Circulation Control	Energy Conserving Recirculation	Normal Control (Default)
			

The functions of the left dipswitch bank

No.	Functions and Dipswitch settings
1 2 3	Output temperature settings (See the table below) (Default 120 °F)



No.	Functions	ON position	OFF position
4	Activation of Individual operation mode **See Section 12-11**	Enable (Default)	Disable
5	Direct vent setting	Enable Direct vent mode	Disable (Default)
6	Outdoor setting	Enable Outdoor mode	Disable (Default)
7	The number of priority combustion unit in a T-M32	Two priority units	One priority unit
8	Parent /Child setting on Easy-link systems	Parent	Child (Default)

12-6. Assigning unit numbers in the Easy-link system

A. How to display the unit number

Press the "**Unit # display**" button on the computer board. The 7-seg LED will then display the assigned number for that T-M32 unit for 10 sec.

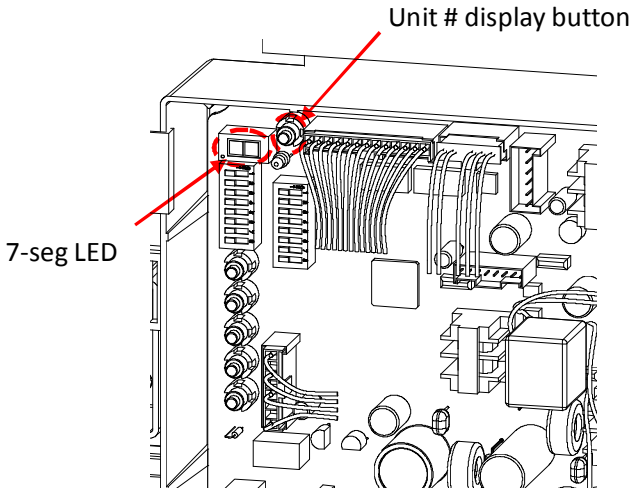
NOTE: In a single-unit installation, the numbering system is disabled.

B. How to reset and reconfigure the numbering of units

Unit #'s can be reset and reassigned manually:

1. Press and hold the "**Unit # display**" button on the computer board of all child units for at least 5 seconds.
2. The 7-seg LED on the computer board of all child units will display "0" to signify that the computer memory has been erased of its previously assigned unit #.
3. **Press and hold the "Unit # display" button again. New unit # will be assigned in order as you proceed through every unit.**

- Each T-M32 in an Easy-link system is assigned a random unit #, except for the Parent unit, which is always assigned as unit #1.
- When more than four units of the T-M32 are connected in an Easy-link system, only the first four units will work as a system. The remaining units will not operate.



Computer board

12-7. (A) ON/OFF conditions: Overview

The following table shows the ON/OFF conditions of the water heater.

ON / OFF Conditions	For Every pump modes
Conditions needed to turn ON.	The BTU requirement is more than 14,880 BTU/h AND The water flow rate is more than 0.5 GPM
Conditions needed to turn OFF.	The BTU requirement is less than 11,900 BTU/h OR Inlet temperature is higher than the set temperature OR Output temperature is over 194°F OR The water flow rate is less than 0.4 GPM

12-7.(B) ON/OFF conditions: BTU requirements

A. Calculating the ON/OFF conditions of the T-M32

【Condition needed to turn the T-M32 ON】

$(T_{set} - T_{in}) \times GPM \times 500 > 14{,}880$

【Condition needed to turn the T-M32 OFF】

$(T_{set} - T_{in}) \times GPM \times 500 < 11{,}900$ or $T_{in} = T_{set}$

Where: T_{set} = Set temperature and T_{in} = Inlet temperature

B. Calculation example

Set temperature: $T_{set} = 120^{\circ}F$ Flow rate = 2.5 GPM

【Condition needed to turn the T-M32 ON】

$(120 - T_{in}) \times 2.5 \times 500 > 14{,}880$ $T_{in} < 108.1^{\circ}F$

【Condition needed to turn the T-M32 OFF】

$(120 - T_{in}) \times 2.5 \times 500 < 11{,}900$ $T_{in} > 110.5^{\circ}F$

The outlet temperature at that moment will be 120˚F

C. ON/OFF table

Set temperature (˚F)		Flow rate (GPM)							
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
100	ON	40.5	70.2	80.2	85.1	88.1	90.1	91.5	92.6
	OFF	52.4	76.2	84.1	88.1	90.5	92.1	93.2	94.1
115	ON	55.5	85.2	95.2	100.1	103.1	105.1	106.5	107.6
	OFF	67.4	91.2	99.1	103.1	105.5	107.1	108.2	109.1
120	ON	60.5	90.2	100.2	105.1	108.1	110.1	111.5	112.6
	OFF	72.4	96.2	104.1	108.1	110.5	112.1	113.2	114.1
135	ON	75.5	105.2	115.2	120.1	123.1	125.1	126.5	127.6
	OFF	87.4	111.2	119.1	123.1	125.5	127.1	128.2	129.1
145	ON	85.5	115.2	125.2	130.1	133.1	135.1	136.5	137.6
	OFF	97.4	121.2	129.1	133.1	135.5	137.1	138.2	139.1
155	ON	95.5	125.2	135.2	140.1	143.1	145.1	146.5	147.6
	OFF	107.4	131.2	139.1	143.1	145.5	147.1	148.2	149.1
165	ON	105.5	135.2	145.2	150.1	153.1	155.1	156.5	157.6
	OFF	117.4	141.2	149.1	153.1	155.5	157.1	158.2	159.1
185	ON	125.5	155.2	165.2	170.1	173.1	175.1	176.5	177.6
	OFF	137.4	161.2	169.1	173.1	175.5	177.1	178.2	179.1

12-8. (A)Pump control ON / OFF Conditions (Only for single and Easy-link system)

To run circulation pumps efficiently and effectively, the T-M32 offers four different modes of pump control. The following table shows the pump control ON/OFF conditions for different modes. To change pump control modes, see section 12-5 for dipswitch settings.

"Normal mode" and "Storage tank circulation mode"

There are no specific ON/OFF conditions for these two modes. The circulation pump will receive a constant "ON" signal from the pump terminal on the computer board, and will run continuously.

"Re-circulation mode" and "Energy conserving re-circulation mode"

These functions enable the re-circulation pump to be controlled by the following conditions.

ON/OFF Conditions	Re-circulation mode	Energy conserving re-circulation mode
Conditions that activate the pump	The BTU requirement is more than 14,880 BTU/h* OR 30 minutes have elapsed after previous operation	Inlet water temperature is less than 95°F(35°C) and flow rate is less than 0.8GPM OR 20 minutes have elapsed after previous operation
Conditions that deactivate the pump	5 minutes after activation, if the computer detects a BTU requirement of less than 14,880 BTU/h, the computer will stop the pump in 90 seconds.	1 minute after activation, if the computer detects a BTU requirement of less than 14,880 BTU/h, the computer will stop the pump in 75 seconds.

*The computer records the inlet temperature and the flow rate of the pump during the final minute of its previous operation when calculating the BTU requirement.

12-8. (B) Pump control ON/OFF conditions: BTU requirements for Re-circulation mode

A. Calculating the ON/OFF conditions of the pump

【Condition needed to turn the pump ON】

$(T_{set} - T_{in}) \times GPM \times 500 > 14{,}880$

【Condition needed to turn the pump OFF】

5 minutes after activation, if the computer detects a BTU requirement of less than 18,600 BTU/h, the computer will stop the pump 90 seconds.

$(T_{set} - T_{in}) \times GPM \times 500 < 14{,}880$ or $T_{in} = T_{set}$

Where: T_{set} = Set temperature and T_{in} = Inlet temperature

B. Calculation example

Set temperature: $T_{set} = 120\ ^{\circ}F$ Flow rate = 2.5 GPM

【Condition needed to turn the pump ON】

$(120 - T_{in}) \times 2.5 \times 500 > 14{,}880$ $T_{in} < 108.1^{\circ}F$

【Condition needed to turn the pump OFF】

$(120 - T_{in}) \times 2.5 \times 500 < 14{,}880$ $T_{in} > 108.1^{\circ}F$

C. ON/OFF table (ON values are the same as OFF values)

Set temperature (˚F)	Flow rate (GPM)							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
100	40.5	70.2	80.2	85.1	88.1	90.1	91.5	92.6
115	55.5	85.2	95.2	100.1	103.1	105.1	106.5	107.6
120	60.5	90.2	100.2	105.1	108.1	110.1	111.5	112.6
135	75.5	105.2	115.2	120.1	123.1	125.1	126.5	127.6
145	85.5	115.2	125.2	130.1	133.1	135.1	136.5	137.6
155	95.5	125.2	135.2	140.1	143.1	145.1	146.5	147.6
165	105.5	135.2	145.2	150.1	153.1	155.1	156.5	157.6
185	125.5	155.2	165.2	170.1	173.1	175.1	176.5	177.6

12-9. Multi-unit system ON / OFF conditions

In Easy-link system and Multiple-system, the amount of T-M32's called on to activate depends on the **FLOW RATE** and the **SET TEMPERATURE**.

1. Condition required to activate an additional T-M32:

Flow rate required to activate additional T-M32 = A × n

Where **n**= number of currently activated T-M32's

and **A** is dependent on the set temperature. See table below:

Set temperature		**Factor "A"**	
˚F	**˚C**	GPM	L/min
100 - 120	38 - 49	3.4	13
125,130	52 - 54	3.2	12
140	60	2.9	11
145,150	63 - 65	2.6	10
155 - 185	68 - 85	2.4	9

2. Condition required to reduce the number of activated T-M32's:

A. **In the case of reducing down from two units T-M32's to one T-M32: Flow rate = A / 1.7**

B. **All other cases: Flow rate = A × (n - 2)**

3. Example: Set temperature = 120˚F in a 20-unit system and priority unit is No. 1
(See the table below)

To activate additional T-M32's			**To reduce number of activated T-M32's**		
Unit No.	Flow rate		Unit No.	Flow rate	
	GPM	L/min		GPM	L/min
No.1 ON	0.5	1.9	No.20 OFF	62	234
No.2 ON	3	13	No.19 OFF	58	221
No.3 ON	7	26	No.18 OFF	55	208
No.4 ON	10	39	No.17 OFF	52	195
No. 5 ON	14	52	No.16 OFF	48	182
No. 6 ON	17	65	No.15 OFF	45	169
No. 7 ON	21	78	No.14 OFF	41	156
No. 8 ON	24	91	No.13 OFF	38	143
No.9 ON	27	104	No.12 OFF	34	130
No.10 ON	31	117	No.11 OFF	31	117
No.11 ON	34	130	No.10 OFF	27	104
No.12 ON	38	143	No.9 OFF	24	91
No.13 ON	41	156	No.8 OFF	21	78
No.14 ON	45	169	No.7 OFF	17	65
No.15 ON	48	182	No.6 OFF	14	52
No.16 ON	52	195	No.5 OFF	10	39
No.17 ON	55	208	No.4 OFF	7	26
No.18 ON	58	221	No.3 OFF	3	13
No.19 ON	62	234	No.2 OFF	2.0	7.6
No.20 ON	65	247	No.1 OFF	0.4	1.5

12-10. Operation time for unit rotation

The unit that turns on first is whichever unit the T-M32 decides is the primary unit.
The priority unit will rotate when it reaches 100 ON / OFF cycles or after 12 hours of operation.

NOTE: The priority unit is the unit that turns on first when there is a hot water demand.

When there is a black out and/or cut off for over 50 minutes, priority unit will switch back to Unit #1.

Example: Four units of T-M32s Rotation

A rotation occurs when:

ON/OFF cycles (×100 times) or Hours of operation (12 hours)

	Unit No.1	**Unit No.2**	**Unit No.3**	**Unit No.4**
Priority Unit	1	2	3	4
	Next step			
Priority Unit	4	1	2	3
	Next step			
Priority Unit	3	4	1	2

12-11. Individual unit operation in multiple-system while multi-unit controller (TM-MC01) is under abnormal conditions (Individual operation mode)

A multi-unit system of T-M32s requires the multi-unit controller. If the multi-unit controller undergoes abnormal conditions, the T-M32s can operate as individual units. If this happens, the minimum flow rate of the system changes from 0.5 GPM to 0.5 GPM multiplied by the number of T-M32s. Refer to the following example:

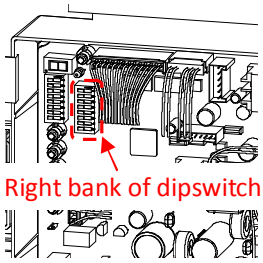
Ex: Minimum flow rate of a five unit multi-unit system.
Under normal conditions: 0.5GPM
When the multi-unit controller fails: 0.5×5=2.5GPM

- Minimum flow rate of the multiple-system depends on the number of the units installed in the multiple-system.
- The set temperature of the units as individual units is the set temperature before the failed communication happened between T-M32 and the multi-unit controller.
- T-M32s will not work individually during with a failed the multi-unit controller if the "**Individual operation mode**" is disabled. See section12-5 "**Individual operation mode**" in Dipswitch settings of the computer board
- In order to make operation system effective during an abnormal condition, the number of individual unit should be half of the total number of T-M32 installed in multiple-system.

12-12. High-Altitude Region Support Functions (FM+ and INPUT-)

＜Using this function＞

The high-altitude region support functions have three operation levels, with the appropriate level being set up by the installer until the abnormal sound problem is solved. The desired level can be specified at the right bank of dipswitches (No.2 and No.3) on the computer board.



Level	Function	Setting Method
0	Standard setting (Default)	Right bank of dipswitches No.2 OFF No.3 OFF
1	the fan motor speed increased by 7.5% (FM+ function)	Right bank of dipswitches **No.2 ON** No.3 OFF
2	Reduction of the max gas input by 10% (INPUT- function)	Right bank of dipswitches No.2 OFF **No.3 ON**
3	the fan motor speed increased by 7.5% (FM+ function) & Lowers the max. input by 10% （INPUT- function）	Right bank of dipswitches **No.2 ON** **No.3 ON**

CAUTION

If the abnormal sound problem persists even with a “Level 3” setting, please contact our Technical Service Department. for advice. Note that there are many high risks associated with manually changing the manifold pressures.

12-13. Checking the Flow Rate by Computer Board

＜Function＞

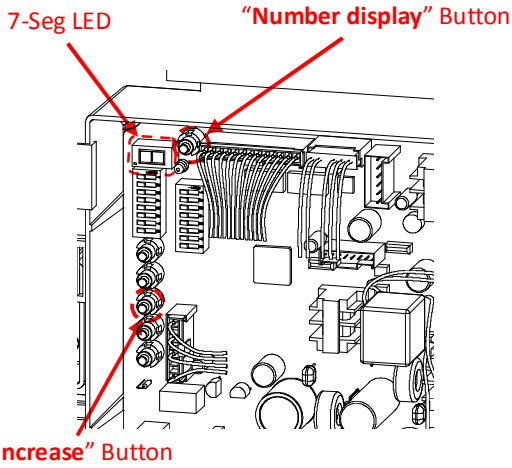
This function offers a method for checking the flow rate in the water heater's troubleshooting operations without having to use the remote controller.

The flow rate check is performed simply by using the "**7-Seg LED**" on the computer board and the "**Increase**" button. The procedure given below can be used to indicate the current flow rate (detected by the flow sensor) at the "**7-Seg LED**". The LED can only display a flow rate range, but this function is nonetheless useful for the computer board and flow sensor diagnostic purposes.

＜Using the function＞

1. When in Standby mode right before ignition (cannot be in combustion, forced-combustion, or the FM adjustment modes), press and hold the "**Increase**" button for 5 seconds or longer to start a display of "A" at "**7-seg LED**". Press the "**Increase**" button a few times to change the display to "d".
2. While "d" is displayed, press the "**Number display**" button to display the flow rate.

The values displayed at the "**7-seg LED**" and their corresponding flow rates are shown in the table below.



7-seg LED display	Flow rate detected by flow sensor [GPM]
0	0 to 0.4
1	0.5 to1.4
2	1.5 to 2.4
3	2.5 to 3.4
4	3.5 to 4.4
5	4.5 to 5.4
6	5.5 to 6.4
7	6.5 to 7.4
8	7.5 to 8.4
9	8.5 or higher

12-14. Relay selection for the pump control connection

The maximum current capacity of the T-M32's pump control connection is 1 amp.

Before using relay with the pump control, please check the specifications of that particular relay to ensure that the current value through the coil will not exceed 1 amp.

For example

To the right, there is a sample of relay specifications from an arbitrary brochure. You can select either the 120 VAC or 240 VAC relay, because their current values are less than 1 A (1,000 mA).

Coil Data @ 25°C

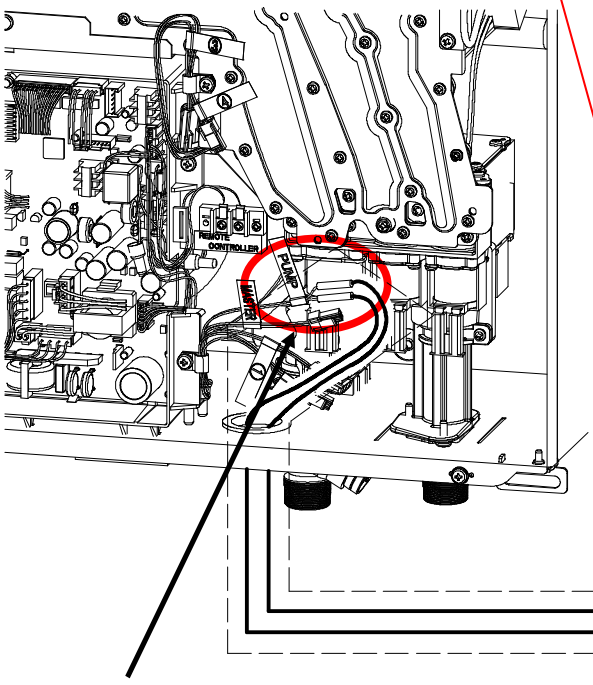
		Nominal Power	Maximum Power
KRP	AC	2VA	Enclosed Models - 4VA
KRPA	DC	1.2W	Enclosed Models - 3W
KA	AC	2VA	Open Models - 4VA
	DC	125mW per movable arm	Open Models - 4W

Duty Cycle: Continuous.
Initial Insulation Resistance: KRP, KRPA - 1000 Megohms, min.
KA - 100 Megohms, min.

Coil Data @ 25°C

	Nominal Voltage	DC Resistance (Ω) ±10%	Nominal Coil Current (mA)
DC Coils	6	32	188
	12	120	100
	24	472	51
	48	1,800	26.6
	110	10,000	11.5
	220	Use 110V relay with 10,000 Ω 5W Resistor in series	
AC Coils	6	6	335
	12	24	168
	24	85	84
	120	2,250	17.5
	240	9,110	8.75

Through this circuit, the maximum current capacity is 1 A



Power supply for relay
Normally 120 VAC

Power supply for pump
120 VAC
220 VAC etc

120 VAC
220 VAC etc

Thermal relay

Recirculation pump

Connect to this "Pump" connector.

These components are not included with water heaters and are external to the unit. They must be acquired separately.

12-15. Adjusting manifold gas pressure

The manifold gas pressure on the T-M32 can be adjusted by following the procedures below.

WARNING

Adjusting the manifold pressure can cause unexpected combustion conditions during operation, which can cause a health hazard, damage the T-M32, and/or shorten its lifespan. Therefore, changing the manifold pressure is not recommended unless there are very strong reasons to do so (e.g. high elevation installations), and with the consultation of the Technical Services Department.

Adjusting maximum manifold pressure

1. Ensure that T-M32 do not in operation.
2. Remove the screw off the manifold port of the T-M32. (Figure 1)
3. Connect a manometer to the manifold port using a tube (Figure 2). Ensure that this connection is secure enough to prevent gas leak.
4. Run water through the T-M32 to activate its operation. If presence of a gas leak is detected, immediately shut off the T-M32 and inspect the tube / manifold connection; otherwise, proceed onto the next step.
5. Press and hold down the **"MAX"** button on the computer board. While holding down the "MAX" button, press either the **"Increase"** or **"Decrease"** button to increase or decrease the manifold gas pressure, respectively (Figure 3). Refer to the manometer to verify that pressure has been set to desired value.
6. After gas pressure has been set, deactivate the T-M32, remove the manometer tube, and replace the port screw.

Adjusting minimum manifold pressure

1. Ensure that T-M32 do not in operation.
2. Remove the screw off the manifold port of the T-M32. (Figure 1)
3. Connect a manometer to the manifold port using a tube (Figure 2). Ensure that this connection is secure enough to prevent gas leak.
4. Run water through the T-M32 to activate its operation. If presence of a gas leak is detected, immediately shut off the T-M32 and inspect the tube / manifold connection; otherwise, proceed onto the next step.
5. Press and hold down the **"MIN"** button on the computer board. While holding down the "MIN" button, press either the **"Increase"** or **"Decrease"** button to increase or decrease the manifold gas pressure, respectively (Figure 3). Refer to the manometer to verify that pressure has been set to

desired value.

6. After gas pressure has been set, deactivate the T-M32, remove the manometer tube, and replace the port screw.

Figure 1

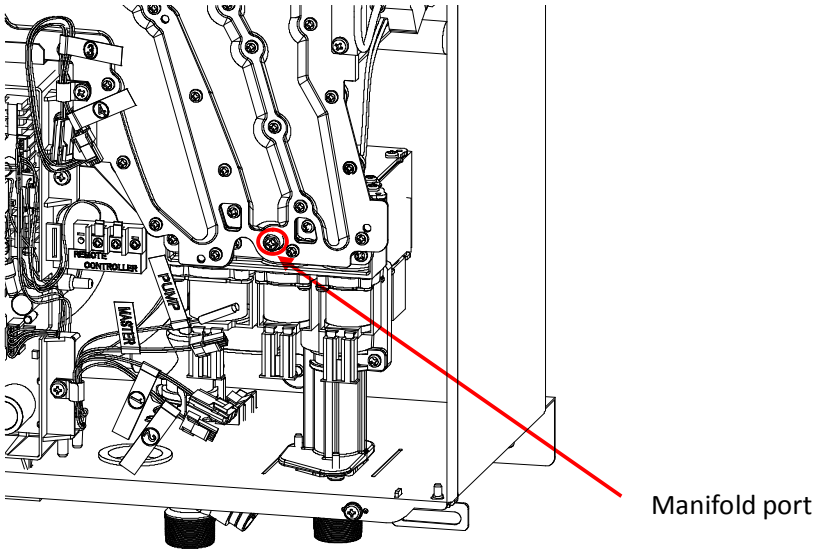


Figure 2

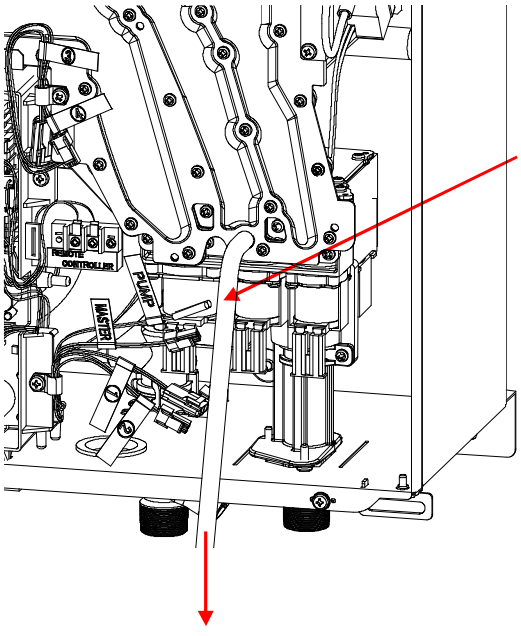
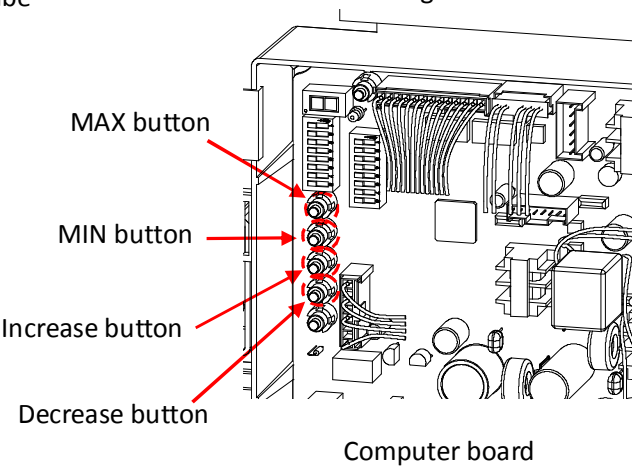


Figure 3



12-16. Manually adjusting the fan motor speed

While the FM+ dipswitch will automatically increase the fan speed by 7.5%, the fan motor speed on the T-M32 can also be manually adjusted. In order to perform manual adjustments to the speed, a remote controller is required.

WARNING

Manually adjusting the fan motor speed of the T-M32 will change the amount of intake air for combustion, which can cause excess CO emission from the exhaust chamber if the fan motor speed is set incorrectly. Therefore, this procedure should **never** be performed unless the Technical Services Department has given consent and authorization.

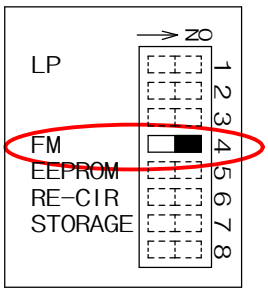
Adjusting maximum fan motor speed

1. While T-M32 is in operation, set dipswitch No.4 on T-M32 computer board to the "ON" position. (Figure 1)
2. On the temperature remote controller, display mode #3 (fan motor speed) by entering the "Diagnostics mode" (Refer to Section 12-1).
3. Press and hold down the **"MAX"** button on the computer board. While holding down the "MAX" button, press either the **"Increase"** or **"Decrease"** button to increase or decrease the fan motor speed, respectively (Figure 2). Refer to the remote controller display to verify that speed has been set to desired value.
4. After fan speed has been set, set dipswitch No.4 back to the "OFF" position.

Adjusting minimum fan motor speed

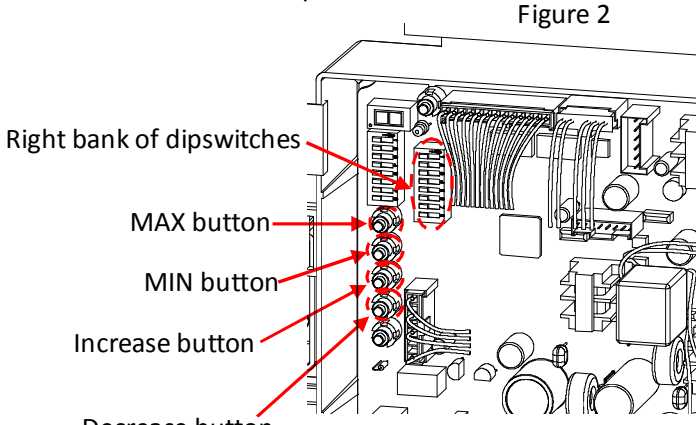
1. While T-M32 is in operation, set dipswitch No.4 on T-M32 to the "ON" position. (Figure 1)
2. On the temperature remote controller, display mode #3 (fan motor speed) by entering the "Diagnostics mode" (Refer to Section 12-1).
3. Press and hold down the **"MIN"** button on the computer board. While holding down the "MIN" button, press either the **"Increase"** or **"Decrease"** button to increase or decrease the fan motor speed, respectively (Figure 2). Refer to the remote controller display to verify that speed has been set to desired value.
4. After fan speed has been set, set dipswitch No.4 back to the "OFF" position.

Figure 1



Right bank of dipswitches

Figure 2



12-17. Freeze protection system

There are two features to the T-M32's freeze protection system: the automatic fan motor system and the ceramic heating blocks. The automatic fan motor system allows the T-M32 to briefly do fan motor operation and the ceramic heating blocks will heat up whatever portion of the heat exchanger the blocks are strapped to.
The automatic fan motor mainly focuses on providing freeze protection from the back flow of the venting. The seven heating blocks focus on protecting the inlet and outlet piping inside the T-M32, as well as the front drum pipe. The conditions to activate either feature are different from each other. However, the two features are not mutually exclusive, because they focus on different areas of the T-M32. As long as each particular feature's activation requirements are met, it is possible for both features to operate at the same time

Ceramic heating blocks

The blocks will only activate based on what the freeze protection thermostat senses. The thermostat is located on the fan motor. Electrical power is required for this feature to operate.
The heating blocks will activate if the thermostat senses a surrounding temperature below 36.5°F.
Once they are on, the heating blocks will only deactivate if surrounding temperatures reach above 46.4°F.

Automatic fan motor system

- This feature is for only **Indoor installation**.
- Electrical power is required for this feature to operate.
- The computer will continually check the temperatures of the inlet, outlet and mixing thermistors.
- Automatic fan motor will not work if the "**Activation of the fan motor freeze protection system**" is disabled. See section12-5.

<Activate condition>

When the computer checks for these temperatures, the Automatic fan motor system will activate if:

$$T_{out} \leqq 46°F \quad \textbf{AND} \quad T_{out} \leqq T_{in} - 5°F$$

where T_{in} is the temperature of inlet thermistor and T_{out} is the temperature of the output thermistor.

<Deactivate condition>

When the computer checks for these temperatures during the fan motor operation as freeze protection, the Automatic fan motor system will deactivate if:

$$T_{out} > T_{in} + 3.6°F$$

OR

$$T_{in} \geqq 50°F \text{ and } T_{out} \geqq 50°F \text{ and } T_{MIX} \geqq 50°F$$

OR

$$T_{in} > 39°F \text{ and } T_{out} > 39°F \text{ and } T_{MIX} > 39°F \text{ and “Flow sensor detects flow rate for 1min”}$$

where T_{in} is the temperature of inlet thermistor and T_{out} is the temperature of the output thermistor and T_{MIX} is the temperature of the mixing thermistor.

12-18. Freeze protection for recirculation systems

<Function and Purpose>
The T-M32 has the freeze protection function for a re-circulation system by using a pump installed in the system. Basically, this function is only ON / OFF control of the pump from the computer in the T-M32. When the computer detects the potential of the system freezing, the pump in the system starts automatically.

To use this function in Easy-link system, the pump must be connected to the pump control port in the computer board of the Parent unit. Refer to Section 12-17 for details.

< While recirculation system freeze protection is in operation>

- While this freeze protection is operating, the computer will display "P" on its 7-seg LED, however, the remote controllers will not display anything on its screen.
- In order to detect the temperature of the system accurately, The computer makes the pump work every two minutes during the freeze protection operation

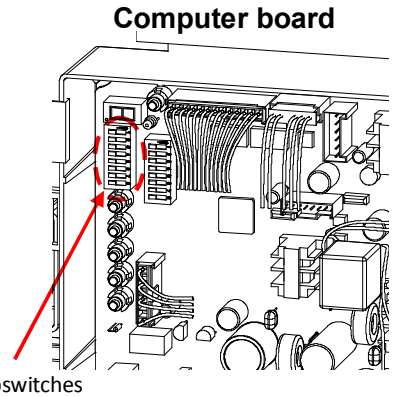
A. Activation conditions (all 3 conditions must occur):

1. Please follow the procedure on the next page.
2. The T-M32 is in non-operation (no call for hot water).
3. The computer (of the parent unit) detects water temperature 50°F (10°C) or below (the computer will activate the pump every two minutes to properly measure water temperatures throughout the recirculation line).

When T-M32 is NOT connected to the remote controller, Change the dipswitch No.4 (the left bank) on the computer board to the "**OFF**" position.

B. Deactivation condition:

After pump has been activated for freeze protection, the pump is set to run for at least 1 hour. After 1 hour has elapsed, the computer (of the parent unit) will actively measure water temperature. Pump will deactivate if temperatures remain above 50°F (10°C) continuously for 10 minutes.



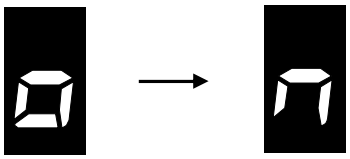
Left bank of dipswitches

<Freeze Protection pump setting mode>
To set the Freeze protection pump mode in T-M32, please follow the procedures below:

1. While in Standby mode (cannot be in combustion, forced-combustion, or FM adjustment modes), press and hold the "**Increase**" button for 5 seconds or longer to start a display of "**A**" at "**7-seg LED**" on the computer board.

2. While "**A**" is displayed, press the "**Number display**" button.
   The "**7-seg LED**" will display "o"…"F"…"F", and then repeat the 3 letters. ("**oFF**" signifies the default setting)

3. While "**oFF**" is blinking, press the "**Number display**" button again.
   The "**7-seg LED**" will display "o"…"n", and then repeat the 2 letters.



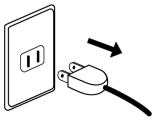
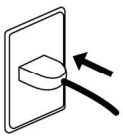
4. While "**on**" is blinking, press the "**Increase**" button to fix the setting.
   "**b**" will then be displayed.

5. Press the "**Decrease**" button to finish the setting.

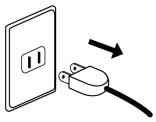
12-19. Draining the unit and cleaning the inlet water filter

1. Close the manual gas shut off valve.

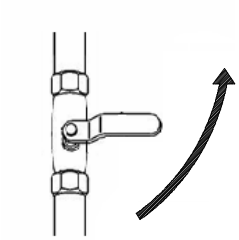
2. Turn off power to the T-M32, wait a few seconds. And then turn on again.

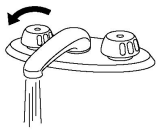
3. Wait 30 seconds for water valves starts to completely open. Then turn off power to the T-M32, yet again.



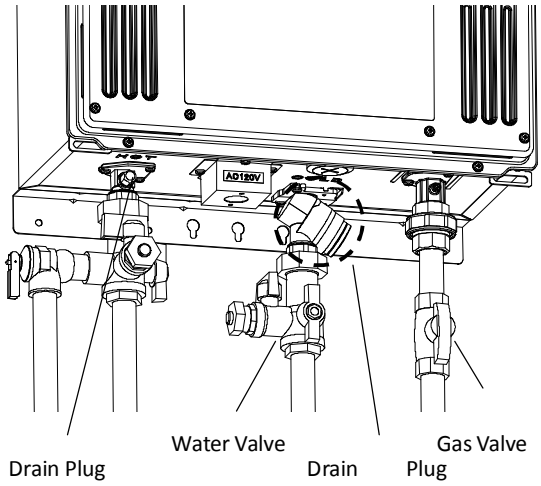
4. Close the water shut off valve.



5. Open all hot water taps in the house. When the all water flow has ceased, close all hot water taps.

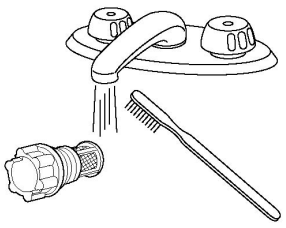


6. Have a bucket or pan to catch the water from the drain plugs of the T-M32. **<u>Unscrew</u>** the drain plugs to drain all the water out of the T-M32.



7. Wait a few minutes to ensure all water has completely drained from unit.

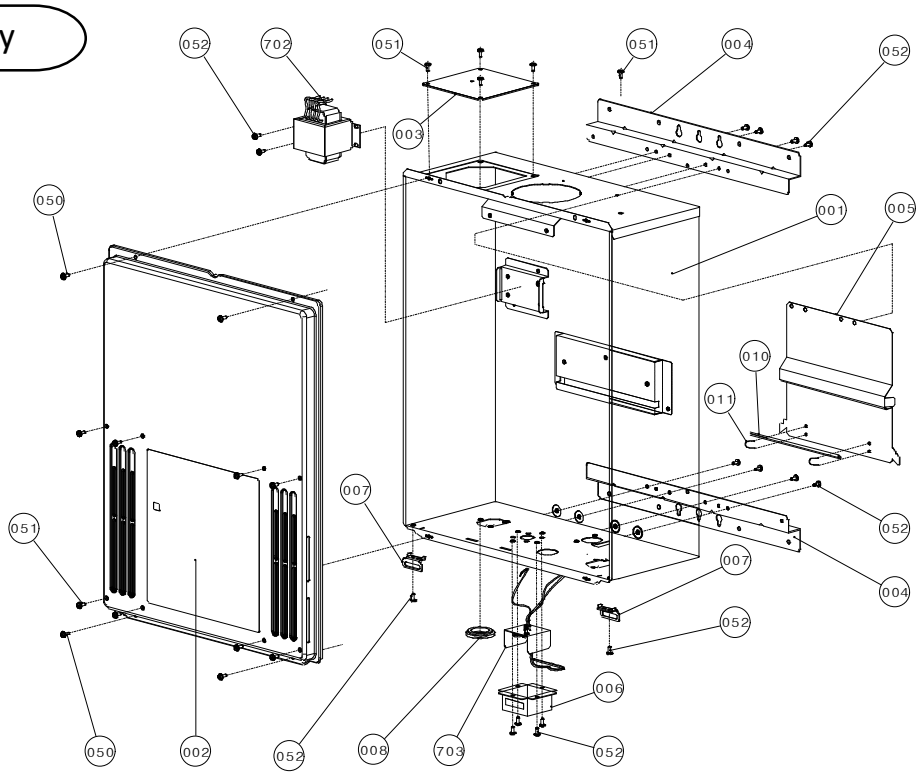
8. **Clean the filter:** Inspect the water filter located within the cold inlet. With a tiny brush, clean the water filter of any debris which may have accumulated and reinsert the filter back into the cold water inlet.



9. Securely screw the drain plugs back into place. **<u>Hand-tighten only.</u>**

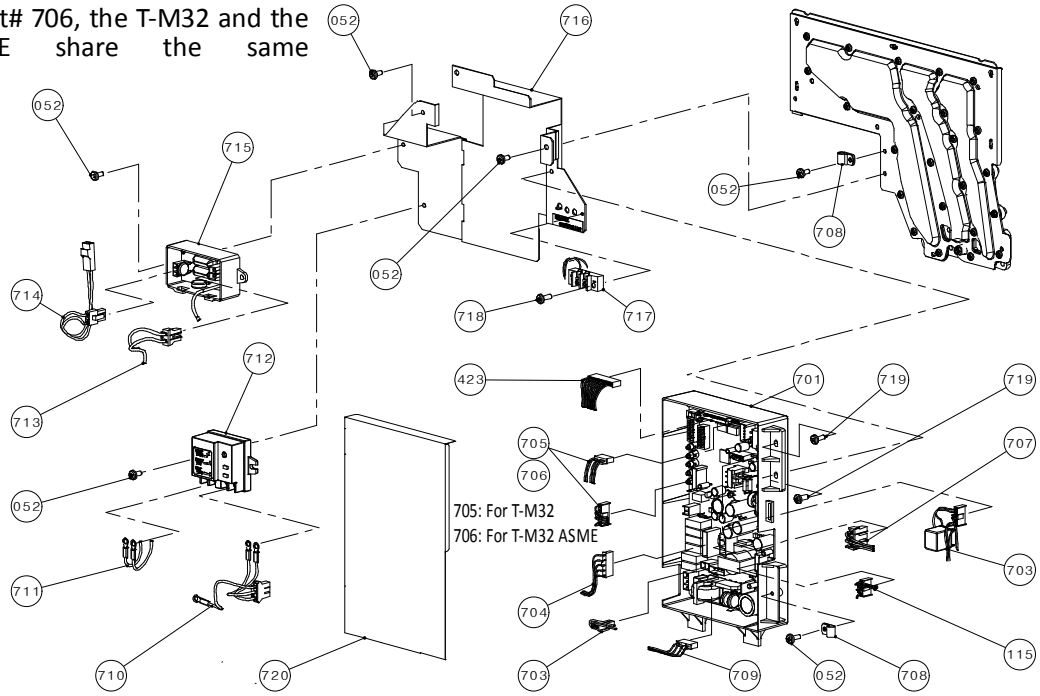
13. Components diagrams

Case assembly



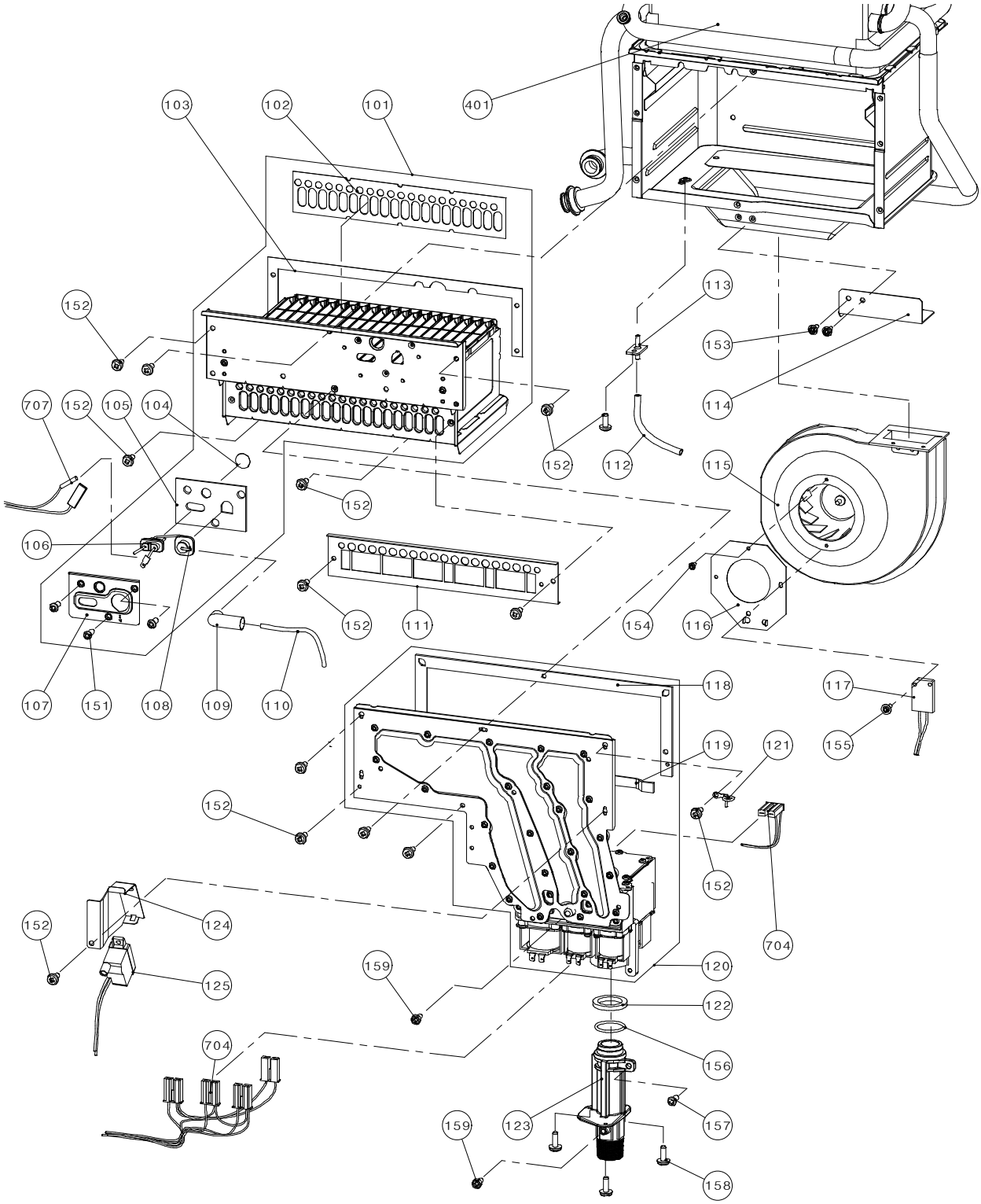
Computer board assembly

Other than Part# 706, the T-M32 and the T-M32 ASME share the same components.



Burner assembly

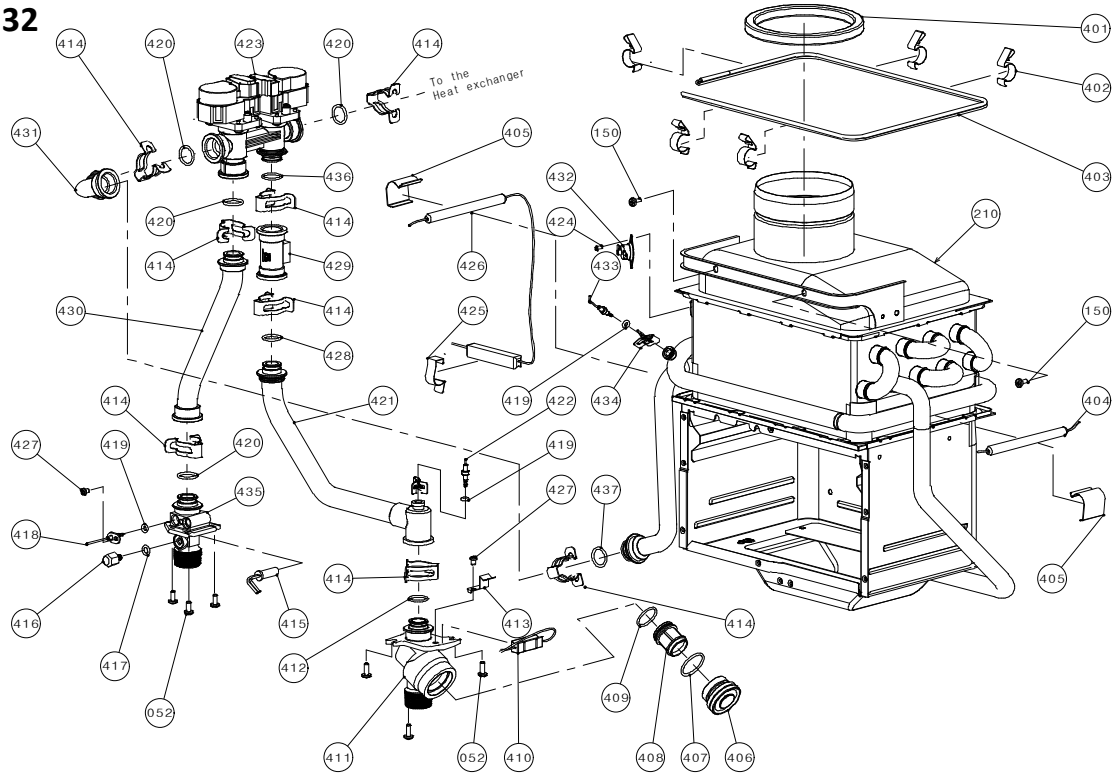
The T-M32 and theT-M32 ASME share the same components.



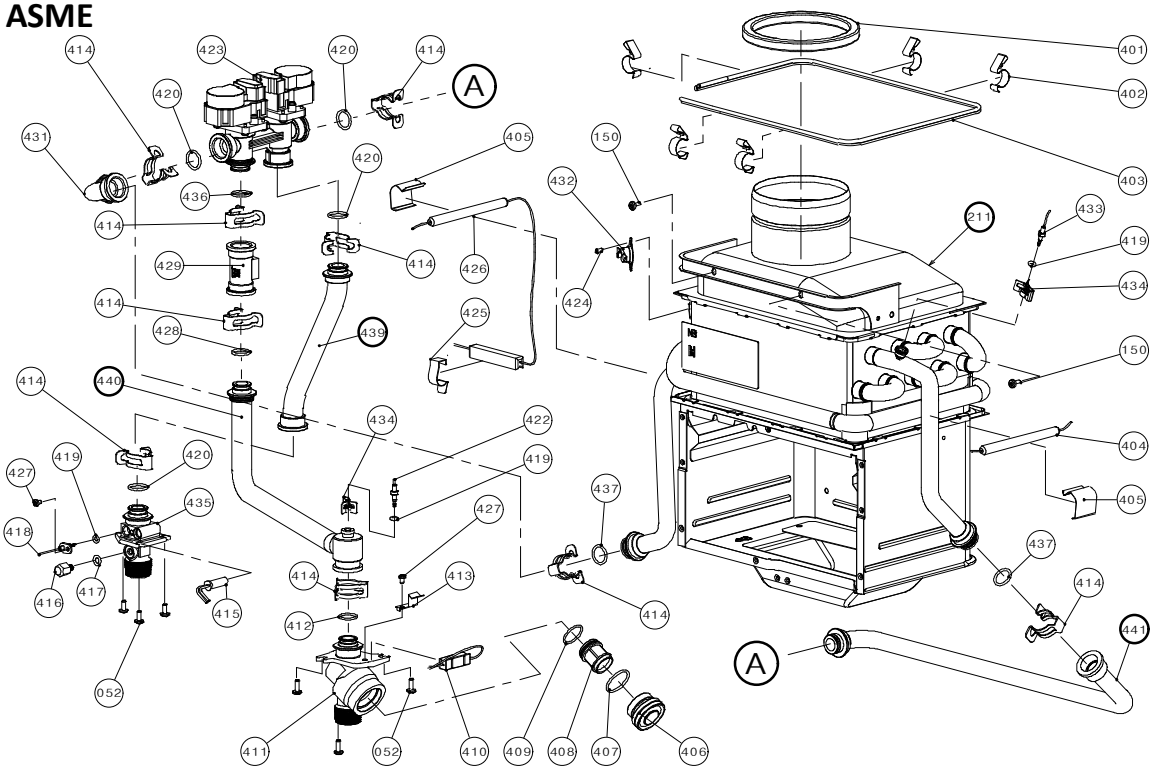
Water way assembly

Other than Part# 211, Part#439, Part#440 and Part# 441, the T-M32 and the T-M32 ASME share the same components.

T-M32



T-M32 ASME



14. Parts list

Item #	Part #	Description	Common parts for other models
1	EM389	Case assembly	
2	EM431	Front cover	
3	EM386	Air blockage plate	
4	EM104	Bracket	
5	EM384	Back guard panel	
6	EKJ64	Junction box	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
7	EX00E	Fixing plate	
8	EX00B	Rubber bush	T-M50
10	EM484	Overheat-cut-off-fuse for combustion chamber	T-H2-DV/OS
11	EKK22	Fastener	T-H2-DV/OS
51	EW001	Screw M4×10 (W/Washer)	*
52	EW002	Screw M4×10 (Coated)	*
101	EM410	Burner assembly	
102	EM411	Burner gasket	
103	EM412	Guide plate gasket	
104	EKK2V	Burner window	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
105	EKK2W	Rod holder gasket	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
106	EKK0E	Flame rod	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
107	EKK32	Rod holder	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
108	EKK0F	Igniter rod	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
109	EKN61	Rod cap	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
110	EX01Z	High voltage ignite cable	

Item #	Part #	Description	Common parts for other models
110	EX01Z	High voltage ignite cable	
111	EM409	Damper	
112	EX02C	Urethane tube	
113	EKK2D	Pressure port	T-K3, T-K3-Pro, T-K3-SP, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
114	EM379	Fan motor fixing plate	
115	EKK25	Fan motor	T-K3, T-K3-Pro, T-K3-SP, T-H2-DV/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
116	EM381	Fan damper	
117	EKJ59	Freeze protection thermostat	T-K3, T-K3-Pro, T-K3-SP, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS
118	EM435	Manifold gasket A	
119	EX00F	Manifold gasket B	
120	EM440	Manifold assembly with gas valve assembly LP	
	EM441	Manifold assembly with gas valve assembly NA	
121	EM167	Wire cramp 60	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
122	EX00D	Gas inlet ring	
123	EM442	Gas inlet	
124	EKK1B	Igniter plate	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
125	EKN74	Igniter	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
151	EW00D	Pan screw M4×8	*
152	EW003	Screw M4×10	*
153	EW00H	Pan screw M4×12 (W/Washer)	*
154	EW00B	Screw M3×6	*
155	EW008	Screw M3×10	*
156	EZP26	O-ring P26 NBR (Black)	
157	EW006	Pan screw M4×10	*

Item #	Part #	Description	Common parts for other models
158	EW001	Screw M4×10 (W/Washer)	*
159	EW005	Hex head screw M4×8	*
160	EW00L	Pan screw M4×6 (W/Washer)	*
210	EM415	Heat exchanger assembly for T-M32	
211	EM45C	Heat exchanger assembly for T-M32 ASME	
401	EKN50	Silicon ring	T-K3, T-K3-Pro, T-K3-SP, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS
402	EKK26	Fuse fixing plate 18	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
403	EM387	Overheat-cut-off-fuse	
404	EKN86	Pipe heater 122	T-M50
405	EKK27	Heater fixing plate	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
406	EM222	Filter plug	T-H2-DV/OS, T-M50
407	EZM25	O-ring P25 EPDM (Purple)	T-H2-DV/OS, T-M50
408	EX006	Water inlet filter	T-H2-DV/OS, T-M50
409	EZN21	O-ring JASO# 1021 EPDM (Purple)	T-H2-DV/OS, T-M50
410	EX002	Heater 101	T-H2-DV/OS, T-M50
411	EM404	Water inlet	T-H2-DV/OS
412	EZN16	O-ring JASO# 1016 EPDM (Purple)	T-H2-DV/OS
413	EX021	Heater plate	T-H2-DV/OS, T-M50
414	EX01H	Fastener “16AG”	T-H2-DV/OS, T-M50
415	EKK2P	Inlet heater	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
416	EK239	Outlet drain plug	T-H2-DV/OS
417	EZM06	O-ring P6 EPDM (Purple)	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
418	EX00H	Mixing thermistor	T-H2-DV/OS

Item #	Part #	Description	Common parts for other models
419	EZM04	O-ring P4 EPDM (Purple)	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
420	EZM16	O-ring P16 EPDM (Purple)	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
421	EM390	Cold pipe	
422	EKK38	Inlet thermistor	T-K3, T-K3-Pro, T-H2-DV/OS, T-D2-IN/OS, T-M50
423	EKH32	Water control valve	T-H2-DV/OS, T-M50
424	EW00A	Screw M3×6	*
425	EK031	Heater fixing plate 16	T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
426	EM45V	Pipe heater 212	
427	EW00L	Pan screw M4×6 (W/Washer)	
428	EZM15	O-ring P15 EPDM (Purple)	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS, T-M50
429	EKH33	Flow sensor	T-H2-DV/OS, T-M50
430	EM391	Hot pipe	
431	EM45G	L joint	
432	EKN34	Hi-limit switch	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-D2-IN/OS, T-M50
433	EKK2T	Output thermistor	T-K3, T-K3-Pro, T-H2-DV/OS, T-D2-IN/OS, T-M50
434	EKH30	Fastener “4-11”	T-K3, T-K3-Pro, T-H2-DV/OS, T-D2-IN/OS, T-M50
435	EKJ02	Water outlet	T-H2-DV/OS
436	EZN17	O-ring JASO# 1017 EPDM (Purple)	T-H2-DV/OS
437	EZM18	O-ring P18 EPDM (Purple)	T-M50
439	EM45E	Hot pipe for T-M32 ASME	
440	EM45D	Cold pipe for T-M32 ASME	
441	EM45F	Connection pipe for T-M32 ASME	
701	EM376	T-M32 PCB	
702	EM454	Transformer	
703	EM463	Junction box inner plate	
704	EM392	Gas valve wire	

Item #	Part #	Description	Common parts for other models
705	EM396	“Flow sensor, Gas proportional valve connection and Thermistors” wire	
706	EM479	“Flow sensor, Gas proportional valve connection and Thermistors” wire for T-M32 ASME	
707	EM395	Flame rod wire	
708	EC00X	Nylon clamp	T-K3, T-K3-Pro, T-K3-SP/OS, T-H2-DV/OS, T-KJr2-IN/OS, T-K4-IN/OS, T-D2-IN/OS
709	EM45T	Igniter & Freeze protection wire	
710	EM393	AC100V wire	
711	EM403	AC100V Transformer connecting wire	T-H2-DV/OS
712	EM207	Ground fault circuit interrupter	T-M50
713	EM400	Power supply code assembly	
714	EM399	AC120V Transformer connecting wire	
715	EM385	Surge box	T-M50
716	EM377	PCB fixing plate	
717	EM398	Remote controller terminal	
718	EW00X	Screw M3×12	
719	EX013	Screw M4×12	T-M50
720	EM478	PCB cover	

15. Records of revision of this manual

Version	Changes	Date
1.00	Sample evaluation	06/27/08
1.01	Revised by the R&D and Takagi Japan	12/09/08
1.02	Revised by the R&D and Takagi Japan	02/12/09
1.03	Revised by the R&D and Takagi Japan	11/22/10